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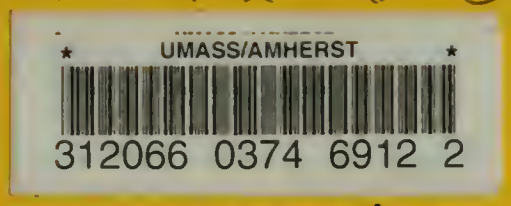

DRAFT

generic environmental impact report

STATEWIDE LIMING OF ACIDIFIED WATERS

1984

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MASS. DIV. FISHERIES AND WILDLIFE

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WESTBORO, MASS.

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The Commonwealth of Massachusetts

Division of Fisheries and Wildlife

Field Headquarters, Westboro 01581

27 December 1984

Mr. James S. Hoyte, Secretary
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, MA 02202

RE: E.O.E.A. #5147, 5148, 5149, 5150 - Draft Report of Generic Environmental Impact Concerning Liming of Acidified Waters; Liming Great Pond; Liming Baker Pond; Liming Schoolhouse Pond

Dear Secretary Hoyte:

Accompanying this letter please find the Draft Generic Environmental Impact Report for the liming of acidified waters statewide.

We believe this report thoroughly addresses the areas scoped under M.E.P.A. regulations. We have also attempted to answer the outstanding issues raised through the public hearing held in Boston and Eastham and letters.

If there are any questions concerning this document, please contact me at 366-4470.

Sincerely,

Peter Oatis
Assistant Director
of Fisheries

PO:er

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Introduction

Recently public awareness of the detrimental biological and economic effects associated with increased acidification of aquatic habitats has prompted considerable political controversy. Consequently a great amount of research is directed at identifying sources of acidification, developing technologies to reduce acidic precursors and methodologies to protect aquatic and terrestrial habitats from the negative impacts associated with increased environmental acidification.

Much of Massachusetts is geologically incapable of naturally buffering the acidic load it currently receives; therefore, the threat of incurring significant biological and economic damage is great. Since the political action necessary to eliminate a large proportion of the acidic precursors is a long way from being resolved, and the Commonwealth has already received a great amount of acidic deposition; immediate mitigative actions must be implemented where and when possible, if the state is to protect and preserve the integrity of its sensitive aquatic ecosystems.

Chapter 130 M.G.L. of Massachusetts charges the Division of Fisheries and Wildlife with protecting and enhancing the inland fisheries and wildlife resources of the Commonwealth. More recently (Chapter 330, Acts 1983) this charge was enlarged to include all forms of wildlife as well as plant life.

Currently the most economical and ecologically effective mitigative action to protect sensitive aquatic ecosystems is the addition of ground limestone. Desired results are obtained when limestone is added in quantities sufficient to maintain optimal pH levels for at least a year or greater.

The Division of Fisheries and Wildlife in fulfillment of their legal responsibility will protect and reclaim the critical and acidified aquatic habitats of the Commonwealth via the application of ground limestone and will actively pursue and evaluate other sound mitigative techniques.

The Environmental Impact Report (E.I.R.) is a response to the legitimate concerns expressed by numerous citizens, conservation commissions and organizations as well as regulatory authorities and lawmakers regarding the Divisions mitigative intentions. This report addresses questions raised at two scoping meetings held in Boston and Orleans on May 19 and 20, 1984 respectively.

By responding to these questions the Division hopes to generate better public understanding of its expertise and decision making processes concerning the need for and ability to conduct effective mitigative actions through the application of ground limestone to sensitive waters.

In pursuing an active program of mitigation it is not the intention of the Division to give the impression that it sanctions existing federal policies regarding acid emissions or that the application of mitigative techniques such as liming, represents a legitimate alternative to the equitable reduction of culturally produced acid precursors.

I - History of the Liming Program in Massachusetts

The phenomenon of decreased biological production associated with increasing acidification of aquatic environments has been known and generally understood for many years (Smith 1872). This relationship was recognized long before the realization of increased environmental acidification stemming from cultural sources; commonly referred to the "acid rain problem."

During the 1940's and 50's investigations conducted in Alabama farm ponds indicated that fish production in acidic waters was enhanced with the addition of low levels of ground limestone (Hasler & Einsele, 1948). These findings prompted the Division to attempt to increase fish production at Berry Pond, a four acre pond located in the Harold Parker State Forest, Andover in 1957. Berry Pond was reclaimed repeatedly from 1953 through 1958 to evaluate its trout production potential. During February and May 1957, 1.25 tons of limestone were added to the pond. No change in pH was noted nor was there a significant increase in the growth of stocked fingerling trout. On the basis of this experiment the Division discontinued the practice of liming to increase fish production.

On April 18, 1963, six acre Little Hell Pond at Fort Devens was stocked with 400 (9-12 inch) rainbow trout. By opening day of the fishing season, April 20, numerous trout were dead while a few were along the shoreline. Water chemistry performed on April 22 indicated a pH of 4.7 and an M.O. alkalinity of 0.8 ppm. Rapid mortality of live caged rainbow, brown and brook trout confirmed the stressful conditions associated with this high acidity. During June and July a total of three tons of agricultural limestone were added to the pond. The pH rose to 6.7 and alkalinity rose to 8 ppm. Subsequent stockings of rainbow trout survived and produced excellent fishing. Follow-up chemical analysis in March 1969 indicated that the pH was still holding at approximately 6.0 and alkalinity was 16 ppm. The retention of the elevated pH was credited to the kettle shape of basin. It was also concluded that the expense of liming was justified in light of the fishing it supported.

The Little Hell Pond experience prompted a trout stocking policy that basically prohibited the release of rainbow trout into waters having a pH below 6, brown trout into waters below pH 5.5 and brook trout into waters below pH 5.0. Since 1965, stocked trout waters suspected of having detrimental acid levels have been monitored prior to the release of hatchery trout.

In the spring of 1969, heavily fished, 45 acre Little Pond, Plymouth had a pH of 4.7 to 4.9. As a result of this information and detailed water chemistry analysis conducted in late spring and early fall it was decided to add 25 tons of limestone to the pond. This was done on November 22, 1969. Follow up monitoring of the pH during the next five years indicated elevated pH levels, ranging from 5.9 to 7.1.

Between 1969 and 1982 the Division conducted 32 liming operations on 1,882 total acres at 27 stocked trout ponds. Five ponds were retreated with lime approximately ten years after the initial treatment. All ponds were essentially kettle basins (table 1). As at Little Pond, the recreational trout fishing opportunities were maintained by the addition of ground limestone.

During 1983 the Division responded to the impact of acid rain on fisheries resources, by broadening its liming program to include more than just stocked trout ponds. For example, in December 1983 College Pond (53) acre was limed. This pond supports a good bass and chain pickerel population that was harmed by increasing acidity.

Because it was beyond the capabilities of state fisheries personnel to monitor springtime pH levels at other than stocked trout ponds, the Division was pleased to lend financial support ($50,000) to the Acid Rain Monitoring Projects (A.R.M.) sponsored by the Water Resources Research Center at the University of Massachusetts, Amherst.

The information generated by this project is vital to the direction and evaluation of all mitigative actions (liming) contemplated by the Division. When completed, the A.R.M. study will have screened the entire state, and it will guide the Division in accomplishing its legislated mandate of protecting and enhancing all fisheries and wildlife resources to the extent practical.

The potential inclusion of all state waters subject to the detrimental effects of increased acidity represents a substantial increase in program scope, cost and effort. Since the dramatic increase in public awareness; of increased environmental acidification, several conservation groups and organizations have expressed concern and the desire to know more about the biological effects and implications of mitigative liming practices prior to seeing the practice applied throughout the state on a much broader basis than has been the case to date.

It is the intent of this E.I.R. to address the concerns as expressed at recent scoping sessions held in Boston and Orleans this spring.

Table 1

Register of Ponds Treated With Ground Limestone ($CaCO_3$) by the Massachusetts Division of Fisheries and Wildlife

	Surface Acres	Date Applied	Quantity Applied (tons)
Berry Pond, N. Andover	3	2/19/57 5/23/57	.75 .50
Little Hell Pond, Ft. Devens	6	6/14/63 7/12/63	1.5 tons 1.5 tons
Pickerel Pond, Plymouth	5	9/03/64	2.2
Little Pond, Plymouth	45	11/22/69	25
Wallum Pond, Douglas	322	2/22/71	350
Schoolhouse Pond, Chatham	21	10/04/71	10
Sheep Pond, Brewster	142	10/05/71	80
Mary's Pond, Rochester	81	10/08/71	45
Fearing Pond, Plymouth	24	10/12/71	15
Fresh Pond, Dennis	29	7/26/72	15
Great Pond, Truro	17	11/05/73	10
Baker Pond, Orleans	32	11/08/73	20
Spectacle Pond, Sandwich	93	11/12,13, 14/73	60
Grew's Pond, Falmouth	13	9/23/74	10
Lout Pond, Plymouth	18	9/19/74	8
Russells-Sawmill Pd. Plymouth	4	9/16/74	2
Big Sandy Pond, Plymouth	134	9/25,26,27, 12/16,17/74	80
Cliff Pond, Brewster	193	9/5-7,9,13, 14, 1977	100
Little Cliff Pd., Brewster	18	9/08/77	20
Flax Pond, Brewster	40	9/11/79	24

Table 1 (Continued)

	Surface Acres	Date Applied	Quantity Applied (tons)
Goose Pond, Chatham	41	9/12/79	20
Deep Pond, Falmouth	24	9/13/79	14
Mares Pond, Falmouth	28	9/13/79	12
Laurel Pond, Erving	51	9/30/82	26
Mary's Pond, Rochester	81	9/09/82	40
Little Pond, Plymouth	45	9/13/82	20
Spectacle Pond, Sandwich	93	9/14,9/15/82	45
Fearing Pond, Plymouth	24	9/16/82	12
PimLico Pond, Sandwich	14	9/17/82	7
Sheep Pond, Brewster	142	9/20-9/23/82	70
Higgin Pond, Brewster	25	9/24/82	11
Hathaway Pond, Barnstable	20	9/29/82	9
Lake Wrights, Ashby	13	10/06/82	5
Comet Pond, Hubbardston	136	10/5-10/08/82	60
Forest Lake, Methuen	55	11/04/82	22
Big Sandy Pond, Plymouth	134	12/12-13/83	40
College Pond, Plymouth	53	12/15/83	20
Fresh Pond, Plymouth	62	12/14/83	20

II. Current Status of Commonwealth Water Bodies

The Division of Fisheries and Wildlife and the Acid Rain Monitoring Group use total alkalinity as a measure of a waterbody's Acid Neutralization Capacity (ANC) to classify the sensitivity of water bodies to additional acid imputs. Based upon alkalinity determinations conducted by A.R.M. volunteers, Division fisheries personnel and D.E.Q.E. personnel at drinking water supply reservoirs, it is evident that 34% of the waters recently sampled (1983) lie within the acidified, critical or endangered status (table 2). The total 1983 sample represent about 28% of the total water bodies in the state. Hopefully through the continued efforts of the A.R.M. project the status of all water bodies in the Commonwealth will be known by the spring of 1985.

The pattern of sensitivity closely correlates with surficial geology. Southeastern Massachusetts, Cape Cod and northern Worcester county appear to be the most sensitive areas of the Commonwealth.

Because the sample selection was not random, it would not be correct to extrapolate these data to the rest of the state, nevertheless it is of value to conclude that acidification of inland waters is a serious problem that requires immediate attention if we are to maintain the integrity of our aquatic resources.

Table 2. Current Status of Commonwealth Lakes
Based Upon 1983-84 Alkalinity Determinations

Status	Alkalinity	A.R.M.	Fish & Wildlife	D.E.Q.E.
Acidified	0	36	--	--
Critical	0-2 ppm	115	18	16
Endangered	2-5 ppm	86	28	28
Highly Sensitive	5-10 ppm	250	29	34
Sensitive	10-20 ppm	271	29	35
Non-Sensitive	20 ppm	217	17	22
Total Sampled		592	121	135

III. Impact of Acidification on Aquatic Ecosystems

A Literature:

In interpreting many of the following statements the reader is reminded that many contradictions or inconsistancies appear within and between the investigations reported in the literature. The principal reason is because the effects of increased acidity in an aquatic ecosystem is but one factor influencing the biological productivity of the system. The ability of the aquatic scientist to predict exactly where, when and how much a given species or community of organisms will be impacted by a specified change in acidity is still the subject of considerable research and often depend upon many factors rather than acidity acting alone.

Despite contradictions concerning specific responses of organisms in individual lakes and streams, researchers agree that species diversity and total productivity decline as the water's pH drops below pH 5.5.

The following paragraphs represent recent summaries of pertinent published information regarding effects of acidification upon various aquatic organisms.

Periphytic Algae: The biomass of periphytic algae has increased in some acidified lakes but species diversity declined (Hendrey et. al. 1976; Leivestad et. al. 1976). Hendrey notes that some of the increased biomass is due to reduced grazing by invertebrates which incurred population reductions as a result of acidification to pH 4.0.

Lake enclosures artificially acidified demonstrated production declines or no change at all when pH was lowered to 5.6 (Muller 1980).

Aquatic Macrophytes: Diverse macrophyte communities in Sweden became dominated by Sphagnum upon acidification (Grahn et. al. 1974). A corresponding dominance was evident in a similar New York lake (Hendreg and Vertucci 1980). These authors believe the increase in Sphagum may accelerate the acidification process because Sphagum has a high ion exchange capacity for calcium.

Phytoplankton: Oligotrophic lakes are usually dominated by Chrysophyceae (golden brown algae), Chlorophyceae (green algae), and Bacillariophyceae (diatoms) (Schindler and Holmgren 1971; Duthie and Ostrofsky 1974). As the pH declines, the species composition changes to Dinophyceae (dinoflagellates) and Chrysophyceae (Almer et. al. 1978; Yan and Stokes 1978; Hendrey et. al. 1980). At pH 4 to 5 Peridinium inconspicuum is frequently the dominant dinoflagellate in acidic clearwater lakes (Almer et. al. 1978; Yan 1979; Hornstrom 1979). Brock (1973) found that blue-green algae did not occur in waters with a pH less than 4.8. Yet blue-green algae dominate in six acidic (pH 4.4-4.9) lakes near Sudbury, Ontario (Kwiatkowski and Roff, 1976).

Analysis of sediments in acidified lakes shows a decrease in the number of planktonic diatoms while a few benthic forms increase (Almer et. al. 1978). Del Prete and Schofield (1981) used sediment cores to show dominance by acidobiotic and acidophilous species in the most acid Adirondack lake. This decrease is most notable in the pH range from 5 to 4, and many species found in oligotrophic lakes are absent from the upper sediment of acidified waters (Almer et. al. 1974).

The proportion of acidophilic species of diatoms in acidified Norwegian lakes increased between 1949 and the mid 1970's (Leivestad et. al. 1976). Although the number of phytoplanktonic species declines with acidification, the total biomass and production may remain constant (Hendrey et. al. 1976; Dillion et. al. 1979; Raddum et. al. 1980). Apparently this is in response to a reduction in phosphorus levels (Almer et. al. 1978). Aluminum, which freely enters solution below pH 6, is capable of removing dissolved phosphorus from the water column by flocculation and precipitation (Almer et. al. 1978) particularly between pH 5 and 6.

Zooplankton: The number of zooplankton species present in a lake decreased as pH dropped below 5.5 in several areas: Sweden (Almer et. al. 1974, 1978); Norway (Hendrey and Wright 1976; Raddum 1980) and Canada (Sprules 1975; Roff and Kwiatkowski 1977; Yan and Strus 1980). In Ontario and Sweden, zooplankton biomass was lower in acidic than similar non-acidic lakes (Dillon et. al. 1979; Roff and Kwiatkowski 1977; Almer et. al. 1978). Acidic lakes in both Scandinavia and Canada are characterized by dominance of bosminids and a scarcity of daphnids and rotifers (Almer et. al. 1974, 1978; Scheider et. al. 1975; Sprules 1975a; DeCosta and Preston 1980; Raddum et. al. 1980; Yan and Strus 1980). When a Canadian Precambrian Sheild lake was acidified to 5.4 from 6.8, the predaceous copepod, Epischura lacustris, and the opposum shrimp, Mysis relicta, disappeared while the number of rotifers, Keratella, cochleares, K. bostoniensis, Polyarthravalgaris and K. longispina increased (Malley and Chang 1981).

Benthic Invertebrates: Okland and Okland (1980) concluded the number of species declined when pH's dropped to a range pH of 4.2 to 5.0. Mollusks are highly sensitive to acidification. Snails were not found in Norwegian lakes with pH at or below 5.2, and were rare or reduced at pH 5.2-6.6 (Okland 1969; J. Okland 1980a, 1980b; Raddum 1980). Of twenty species of fingernail clams, (Sphaerudae) only six are found in lakes with pH less than 5 (K. Okland 1980). Mollusks are not found in Ontario lakes with pH at or below 5 (Scheider et. al. 1975; Scheider and Dillan 1976; Roff and Kwiatkowski 1977). In crayfish exposed to acidic water, calcium uptake was inhibited at pH below 5.75 and the progression of molt stages and calcification of the exoskeleton were reduced at pH 5.0 (Malley 1980). Accordingly, Astacus astacus is rare in lakes with pH less than 6.0 (Almer et. al. 1978) while Cambarus latimanus is not found at pH 5.6 or below (Hobbs and Hall 1974).

Since certain groups of sponges require calcium carbonate to form specules, they may be eliminated from acidified waters. Jewell (1939) found that calcium was an important factor in the distribution of sponges in Wisconsin.

Aquatic Insects: Some groups of aquatic insects are reduced at low pH while others flourish. This may be because of direct physiological impact of acids or toxic metals, alteration of food supply, or changes in predator-prey relationships. Bell (1971) found that pH was directly lethal to some benthic invertebrates, emergence was the most critical period. The lowest pH at which 50% of the adults emerged was 4.0 for the most tolerant species of Trichoptera and 5.9 for the least tolerant Ephemeroptera species. Bell and Nebeker (1969) and Butler et. al. (1973) noted similar findings. Potts (1979), and Potts and Fryer (1979) found that exposure to low pH causes a reduction in sodium uptake and an increase in sodium loss from sensitive invertebrates.

In Norway there were eight to 12 species of Ephemeroptera and Plecoptera in lakes with a pH of 6.5 or above. Lakes having a pH of 4.0 to 4.5 held only one to two species (Hendrey and Wright 1976). Scheider and Dillon (1976) report that Ephemeroptera were absent from acidic lakes in Ontario. In a laboratory study, Bell (1971) found that Ephemeroptera were intolerant of low pH and Plecoptera were moderately tolerant. Bell (1970) also noted the life cycle of the midge Tangtarsus dissimilis could not be completed below pH 5.5. In Ontario, Chaoborus sp. were absent from acidic lakes (Scheider et. al. 1975; Scheider and Dillon 1976).

Raddum (1980) notes that Coleoptera, Hemiptera (Corixidae) and Megaloptera were more abundant in lakes with pH below 4.8 than in pH 7 lakes. Nilssen (1980) found Hemiptera and Coleoptera at increased abundance in Norwegian lakes as pH declined. Mossberg and Nyberg (1979) found Odonata, Heteroptera and the Dipterans, Chaoborus sp. and Chironomus sp. very abundant in lakes with pH 4.2 to 5.0. Their findings or Dipterans conflicts with Raddum (1980) in Norway; Scheider and Dillon (1976) in Ontario and Hall and Likens (1980) in New Hampshire. The difference may be caused by a species specific response pattern. Bell (1971) found Trichoptera were tolerant of reduced pH and Odonata were moderately tolerant.

Fish: The impact of acidification on fish has been extensively studied and the mechanisms of loss have been documented. Haines (1981) gives a listing of species and the pH at which they cease to reproduce or disappear (Table 3). Due to differential response of various strains, life stages and levels of acclimation , we use Harvey's (1979) chart explaining the limits of species more typically found in this area. In addition, Harvey's research locale is similar to our state's environment.

Basically acidification can impact a fish population by causing an outright mortality of adults, eliminate recruitment, prevent spawning, or cause larval deformities. These impacts can occur directly due to acidification or indirectly as toxic metals exacerbated via acidification.

Table 3

-Species of fish that ceased reproducing, declined, or disappeared from natural populations as a result of acidification from acidic precipitation and the apparent pH at which this disappearance occurred (from Haines, 1980).

Family and species	Apparent pH at which population ceased reproduction, declined, or disappeared (reference)[a]
Salmonidae	
Lake trout, *Salvelinus namaycush*	5.2-5.5 (1); 5.2-5.8 (2); 4.4-6.8 (3)
Brook trout, *Salvelinus fontinalis*	4.5-4.8 (4); 5 (5)
Aurora trout, *Salvelinus fontinalis timagamiensis*	5.0-5.5 (6)
Artic char, *Salvelinus alpinus*	5 (7)
Rainbow trout, *Salmo gairdneri*	5.5-6.0 (4)
Brown trout, *Salmo trutta*	5.0 (4); 5.0-5.5 (8); 4.5-5.5 (9)
Atlantic salmon, *Salmo salar*	5.0-5.5 (4)
Lake herring, *Coregonus artedii*	4.5-4.7 (1); <4.7 (2); 4.4 (3)
Lake whitefish, *Coregonus clupeaformis*	<4.4 (3)
Esocidae	
Northern pike, *Esox lucius*	4.7-5.2 (2); 4.2-5.0 (3)
Cyprinidae	
Golden shiner, *Notemigonus crysoleucas*	4.8-5.2 (3)
Common shiner, *Notropis cornutus*	<5.7 (3)
Lake chub, *Couesius plumbeus*	4.5-4.7 (1)
Bluntnose minnow, *Pimephales notatus*	5.7-6.0 (3)
Roach, *Rutilus rutilus*	5.3-5.7 (7)
Catostomidae	
White sucker, *Catostomus commersoni*	4.7-5.2 (1,2); 4.2-5.0 (3)
Ictaluridae	
Brown bullhead, *Ictalurus nebulosus*	4.5-5.2 (1,2); 4.6-5.0 (3)
Percopsidae	
Trout-perch, *Percopsis omiscomaycus*	5.2-5.5 (1)
Gadidae	
Burbot, *Lota lota*	5.5-6.0 (1); 5.2-5.8 (2)
Centrarchidae	
Smallmouth bass, *Micropterus dolomieui*	5.5-6.0 (1); >5.5 (2); 5.8 (10); 4.4-5.0 (3)

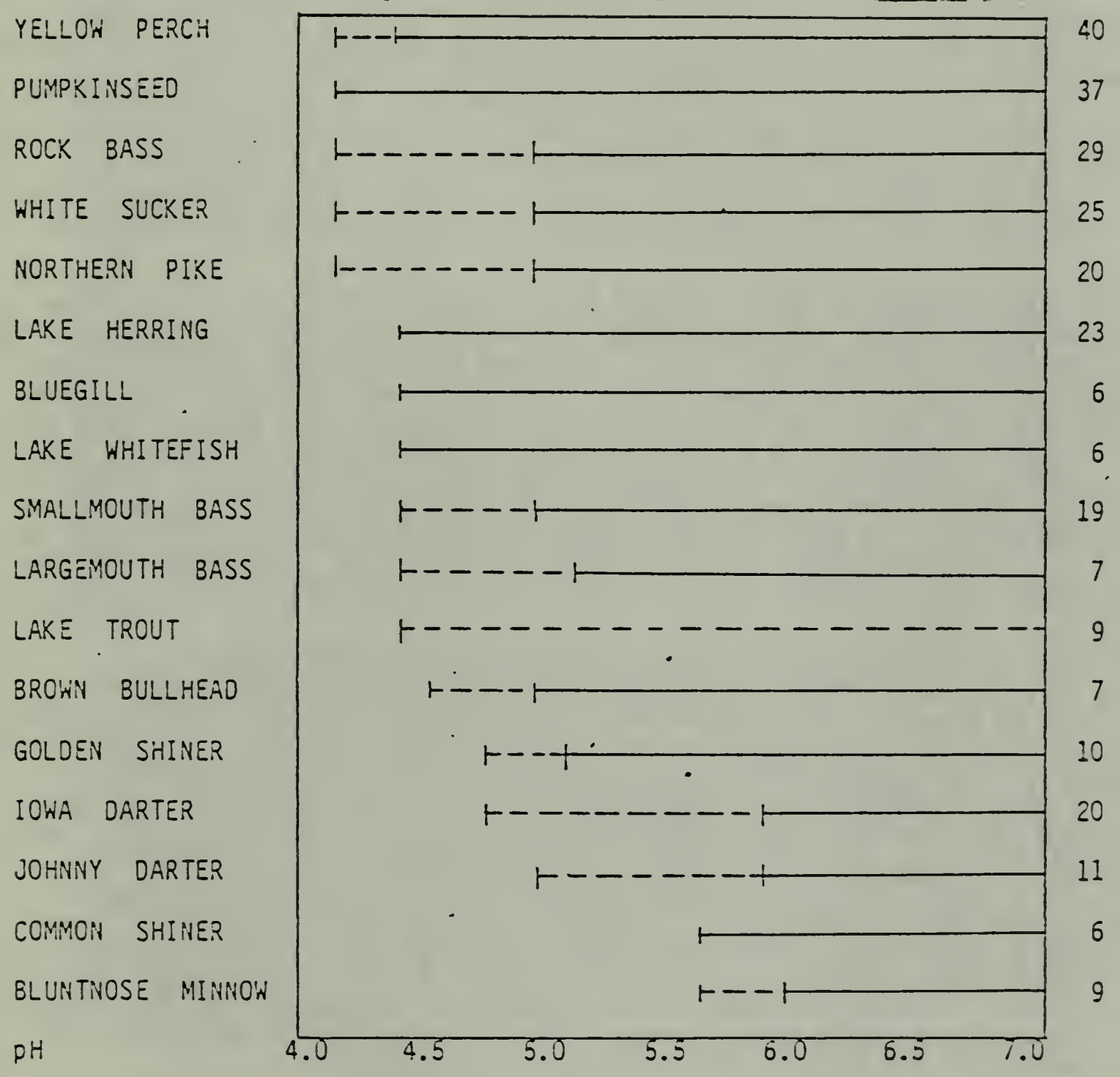
Table 3 (Continued)

Family and species	Apparent pH at which population ceased reproduction, declined, or disappeared (reference)[a]
Largemouth bass, Micropterus salmoides	4.4-5..2 (3)
Rock bass, Ambloplites rupestris	4.7-5.2 (1,2); 4.2-5.0 (3)
Pumpkinseed, Lepomis gibbosus	4.7-5.2 (1); <4.2 (3)
Bluegill, Lepomis macrochirus	<4.2 (3)
Percidae	
Johnny darter, Etheostoma nigrum	5.0-5.9 (3)
Iowa darter, Etheostoma exile	4.8-5.9 (3)
Walleye, Stizostedion v. vitreum	5.5-6.0 (1); 5.2-5.8 (2)
Yellow perch, Perca flavescens	4.5-4.8 (1); <4.7 (2); 4.2-4.4 (3)
European perch, Perca fluviatilis	5.0-5.5 (11)

[a] References: (1) Beamish 1976; (2) Beamish et al. 1975; (3) Harvey 1980; (4) Grande et al. 1978; (5) Schofield 1976; (6) Anonymous 1978; (7) Almer et al. 1974; (8) Jensen and Snekvik 1972; (9) Wright and Snekvik 1978; (10) Pfeiffer and Festa 1980; (11) Runn et al. 1977.

Figure 1

POPULATION RESPONSES OF FISHES IN ACIDIFIED WATERS (FROM HARVEY, 1979)



Occurrence of fish species in relation to lake pH. The vertical bar defines the lowest lake pH recorded for the species; the dashed line represents species present in which populations are very small, malformed or not reproducing; the solid line denotes populations which appear to be unaffected.

The impact of acidification can be ameliorated by the presence of other chemicals. Therefore each aspect will be addressed separately.

The lower pH limit of fish survival for tolerant species is about 4.0 (Figure 1). At this level, death occurs from one of two problems; chemical suffocation or ionic imbalance (Utsch and Gros 1979; Packer and Dunson 1970), and/or suffocation which occurs when the leaflike secondary lamellae of the gill secrete excess mucus to protect the organ from erosion and edema (Packer 1979). This mucus increases the diffusional resistance to oxygen, a situation aggravated by the body's blood response to low pH. As the blood pH drops toward the environmental level, the hemoglobin's carrying capacity for oxygen is reduced and less O_2 is available for the tissues. Lesser acid events cause increased ventilation which may occur at a significant metabolic cost (Rosseland 1980).

Packer and Dunson (1970) suggested that death involves a failure of the ion exchange system. Both the uptake and expulsion of sodium is reduced at low pH (McWilliams and Potts 1978). A number of researchers, (Mudge and Neff 1971, Muniz and Leivestad 1980, and Leivestad and Muniz 1976) have correlated the rate of mortality from stress induced by acid water. There are dramatic increases in the concentration of blood cells (McDonald et. al. 1980) and intracellular potassium is excreted (Fugelli and Vislie 1980). The ionic stress noted above can be ameliorated by calcium and perhaps magnesium. The calcium helps control ion exchange at the gills (Maetz et. al. 1976; McWilliams and Potts 1978). Leivestad et. al. (1980) improved brown trout survival at pH 4 by increasing calcium from 0.4 to 0.9 mg/l.

While calcium aids survivability, other metals do not. This is particularly significant since acidification elevates metal content. Sinley et. al. (1974) estimated the toxic limit of zinc for rainbow trout in soft, circumneutral water was between 0.4 and 0.26 mg/l. Duodoroff and Katz (1953) noted 6 mg/l was the lowest concentration toxic to fish. A number of researchers (Schofield and Trojnar 1980, Baker 1981, and Muniz and Leivestad 1981) found aluminum toxic to fish at 0.1 to 0.2 mg/l. More specifically, Baker and Schofield (1981), Driscoll et. al. (1980) and Baker (1981) found that inorganic aluminum (free aluminum and aluminum hydroxide) were most toxic. Aluminum fluoride had a reduced toxicity while organically complexed aluminum was non-toxic. This may partially explain why some fish can survive in acid bogs, where most of the aluminum present is bound by organic ligands making it non-toxic. The toxic form of aluminum precipitates on the gills as aluminum hydroxide (Baker 1981, Schofield and Trojnar 1980, Muniz and Leivestad 1981).

The impact of acidification on reproduction and recruitment is less clear. This is because spawning, early development and fry life history are actually very distinct stages, each with different stimuli and sensitivities within and particularly between species.

First, most fish in Massachusetts spawn in the spring, April-June, or fall, October-November, and are subject to heavy acid inputs which may cause a rapid change in pH. Even those fish spawning in the fall and avoiding low pH situations leave their progeny vulnerable to hatching at snowmelt, a time of extremely low pH. Brook trout avoid upwellings of pH 4.0-4.5 water in selecting a redd site (Johnson and Webster 1977), but emerge from their buffered redd environments only to encounter surface water pH values up to four points different (Schofield 1976b, Trojnar 1977a). Next, these heavy acidified runoff events tend to mobilize Al ions and iron. Even the redd environment changes during incubation. In a low permeability situation, Lacroix (1980) found the interstitial water of Atlantic salmon redds dropped as much as 1.5 pH units at the eight to ten inch depth. The interstitial carbon dioxide concentration increases as the pH declines (Williams and Hynes 1974). These factors can synergystically cause mortality. In maturing female white suckers suffering acid stress (pH 4.8-5.3), a failure to produce mature eggs or release them was related to low serum Ca during oogenesis and oocyte maturation (Beamish et. al. 1975; Lockhart and Lutz 1977). Apparently this low Ca metabolism causes faulty protein deposition in the oocyte. Another aspect of reproduction impacted by acid involves sperm mortility and survival. While Inaba et. al. (1958) found trout sperm to be mobile within the pH range of 4.5-10.4, the greatest activity occurred in levels above pH 7. Duplinsky (1982) found the sperm of northern pike became immobile below pH 5.4. Apparently fertilization will not occur below pH 4.0 since Petit et. al. (1973) found significant decreases in egg fertilization at low pH and sperm become immobile. Once fertilized, the egg will adjust the internal pH to 0.4 to 0.8 units above ambient pH (Johansson et. al. 1977). Apparently this is accomplished by releasing mucopolysaccharide or bicarbonate from the epidermis. Even the hatching of the egg is impacted by low pH. Runn et. al. (1977) demonstrated the outside jelly layer was more dense in eggs incubated at pH 4.5 than those at pH 7.3. In addition, the inner layer remained intact at pH 4.5 while it dissolved at the higher pH. Apparently, a protease enzyme and a metal (probably Ca++) break down the egg case (Hagenmeir 1974). To function, it must have a basic environment, which is not available in eggs adjusting to low pH. And the outside layer, being thick at low pH, is difficult for the larvae's snout to rupture. Runn et. al. (1977) indicated this problem caused delayed hatching and skeletal abnormalities of the jaw. Daye and Garside (1979) found salmon alevins hatching at low pH (4.1) remain partially encapsulated because of the shell's toughness at low pH.

In explaining egg response to low pH, many investigators note their observations must be adjusted with aluminum present. Daye (1980) felt the early cleavage stage was the most sensitive embryonic period with the remainder being only moderately sensitive. At hatching Daye and Garside (1979) found Atlantic salmon alevins become very sensitive to low pH again. This sensitivity perhaps increases through the yolk absorption stage (Farmer et. al. 1980). Yet Baker (1981) found at low pH levels (4.2-4.8) aluminum improved egg survival through the eyed stage for both brook trout and white suckers. This improvement continued through hatching for the trout. At the next life stage, the fry suffered reduced growth and excessive mortality at Al concentrations of 0.1 mg/l for white suckers and 0.2 mg/l for brook trout.

Another impact of acidification is its influence on skeletal development. Beamish et. al. (1975) reported deformities in white suckers. Trojnar (1977a) and Beamish (1972) were able to produce the same skeletal defects in the laboratory.

Amphibians: Many studies have shown that low pH can affect amphibians, but the method is not fully understood. Gosner and Black (1957) found reduced numbers of frog species in the acidic waters of the New Jersey Pine Barrens. Only four of 11 species could reproduce below pH 4.2. Pough and Wilson (1976) observed that hatching mole salamanders (Ambystoma maculatum) did not tolerate pH below 6. However, Cook (1978) found low mortality rate and no correlation between mortality of this species and pH of breeding ponds ranging between pH 4.0 and 6.0. Huckabee et. al. (1975) found larval shovelnose salamanders (Leurognathus marmoratus) died in a creek whose pH ranged from 4.5 to 4.9 and had an aluminum concentration of 1.0 mg/liter.

Perhaps the influence of high Al and its hydroxides greatly impairs gill functions on larval salamanders.

Birds and Mammals: In the Adirondacks, the Common loon (Gavia immer) have declined (McIntye 1979) but the reason for it is unclear. Goldeneye ducks (Bucephala clangula) favored acidic lakes which lacked fish in order to avoid competition for the aquatic insects (Ericksson 1979).

Mammals have not been shown to be directly affected by acidification of waters, however, the carrying capacity of a given acidified watershed will reflect entire food web associations as aquatic organisms increase or decrease in abundance.

B. Massachusetts Experience:

Lakes - The implementation of the 1965 trout pond stocking policy prompted the Division to embark upon the practice of adding low levels of ground limestone to stocked trout ponds when spring pH levels dipped below 5.5.

Because no adverse effects of low level liming were reported in the literature and subsequent water chemistry data and fish community assessment surveys indicated no significant biological fisheries problems existed at limed ponds; detailed investigations were not conducted to assess biological impacts of liming.

However, recent fisheries assessments at non-stocked or limed ponds indicates that acidification of some lakes may be stressing existing fish populations.

A case in point is Little Sandy Pond, Plymouth; in 1952 it had a pH of 5.6. Fish sampling in 1971 indicated healthy populations of chain pickerel,

yellow perch, brown bullhead, pumpkinseed, banded sunfish and tesselated darters. A similar survey conducted in 1982 indicated the pH had dropped to 4.2 while banded sunfish were absent and remaining species demonstrated erratic or unsuccessful reproduction (Table 4).

Streams - A recent fisheries survey of the Millers River Watershed indicates the loss of fish community diversity is due to advancing acidification when compared to 1956 data. Tributaries of the 16 sampled, two streams were completely devoid of fish, and seven had incurred losses of one to five species of non game fish. Additionally some of the streams not incurring species losses demonstrated reproductive failure of one or more species.

Inspection of recently surveyed stream chemistry data indicates 19% of 4,500 miles of streams fall into the acidified category. To date the Division has not attempted to notify stream habitats via limestone applications because cost effective techniques are still in the development and demonstration stage. Plans are presently being formulated to build a stream mitigation liming device which applies the technologies recently developed for addressing the problem in Scandanavian streams.

Table 4. Comparison of the 1971 and 1982 Fisheries Surveys for Little Sandy Pond, Plymouth

Species	1971			1982		
	Number	Average Size	Range	Number	Average Size	Range
Chain Pickerel	30	216	63-531	11	147	51-544
Yellow Perch	79	195	51-340	122	188	114-277
Brown Bullhead	34	241	165-302	52	218	190-277
Pumpkinseed	8	124	38-213	9	155	140-188
Banded Sunfish	9	38	25-60	--	--	--
Tesselated Darter	3	38	38-48	2	38	38-48

IV. Potential Impacts of Acidification Control Techniques

A. Literature:

The proposal before Massachusetts Environmental Protection Act (M.E.P.A.) involves spreading finely ground agricultural limestone (Appendix 3) over the surface of the acidified lake. Application amounts vary from .1 to .8 oz./sq ft. The potential impact of this technique can be divided into three areas; physical, chemical and biological. Each will be reviewed in light of our criteria for selecting candidate ponds (Section VI).

Physical

There are only a few physical changes which may occur subsequent to liming and these changes are opposite to the changes brought on by acidification. Yan and Dillon (1981) found an immediate improvement in transparency followed by a long-term reduction in transparency when severely acidified lakes were limed. Hultberg and Andersson (1981) found similar results in six Swedish lakes. They attributed the reduced transparency to increased numbers of small chrysomonads in the epilimnion. In liming a less acidic lake (pH 5.7), there was no effect on transparency (Yan and Dillon 1981).

When the transparency is appreciably reduced, the depth of the epilimnion and the thermocline may be reduced in mid to late summer. Accordingly, the depth of the hypolimnion may increase, while the temperature of the hypolimnion may decrease (Hultberg and Andersson 1981; Yan and Dillon 1981).

Chemical

The chemical reaction of limestone in acidified water is as follows:

1) $CaCO_3 + H+ \longleftrightarrow Ca^2 + HCO_3$
2) $HCO_3 + H+ \longleftrightarrow H_2CO_3$
3) $H_2CO_3 \longleftrightarrow H_2O + CO_2$

Pearson and McDonnell (1975a) indicate that reactions one and three are much slower than two which is almost instantaneous. If free CO_2 is lost or unavailable, the remaining limestone precipitates. Because of this, a given lake may respond in a number of different ways to the addition of lime over the short term. Hultberg and Andersson (1981, 1982) found one Swedish lake's epilimnion responded rapidly to an April liming by boat. The hypolimnion responded during the fall circulation. Yet another lake, limed on the ice in March showed a similar increase in pH as the boat-limed lake, but the alkalinity and calcium did not reach maximal values for two years. Alkalinity is increased through the increase in anions (HCO_3), while the cations (Ca+) raises the hardness.

Liming causes a decrease in the concentration of metals mobilized through acidification (Bernhoff 1979). These metal concentration decreases can occur either by direct precipitation or settling of phytoplankton or zooplankton blooms (Yan and Dillon 1981). Direct precipitation can range from 32 to 95% for copper, 22 to 73% for nickel, 15 to 89% for zinc, 15 to 89% for iron, 15 to 79% for manganese and 66 to 91% for aluminum (Dillon et. al. 1977; Yan et. al. 1979; Yan and Dillon 1981). As the figures show,

there is a wide array of responses possible in any given lake which is limed. Since aluminum has proven to be most toxic to fish in acid conditions, it has been most closely analyzed. Aluminum is hydrolized by lime and may become toxic prior to precipitating. Dissolved organic carbon or any organic ligand can eliminate its' toxicity (Driscoll et. al. 1980). Unfortunately the dissolved organic carbon is generally lost to the water column subsequent to liming. Thus, Driscoll et. al. (1982) hypothesized that future acidification may result in new or resolubilized aluminum remaining in a toxic inorganic form because there is little dissolved organic carbon to bond to the aluminum. Another critical metal, mercury, appears to be mobilized by liming and then concentrated in fish flesh (Brosset and Svedung 1977). However, research in acid and limed Adirondack lakes by Sloan et. al. (1979), found no increase in mercury from either limed or acid waters.

Another major study area involves the impact of lime on nitrogen and phosphorus. While early work on humic water lakes (Hasler 1951, Waters 1956) showed an increase in total phosphorus, recent studies have found no measurable change (Yan and Dillon 1981; Hultberg and Andersson 1981; 1982). Bingtsson (1982) reports an initial lowering of available phosphorus, but a return to normal levels in time. This can perhaps be explained by Dickson's (1978) observation that aluminum removes phosphorus as it precipitates. The response of nitrogen to liming varies depending on organic/inorganic status. Hultberg and Andersson (1981) found inorganic nitrate nitrogen remained constant in the epilimnion and decreased in the hypolimnion. The organically bound nitrogen increased, causing a net increase in total nitrogen. Yan and Dillon (1981) found similar short-term results but did not notice any long-term change in total nitrogen.

Biological

Most biological effects are determined by the physical and chemical environment in which they occur. In addition, the highest predators can only exist if there is an extensive community of autotrophs and heterotrophs to provide stability. Therefore these issues will be addressed from the bottom to the top of the biological pyramid.

Scheider and Dillon (1976) found that neutralizing acid lakes in Canada cause aerobic heterotrophic bacteria to change their taxonomic composition and dramatically increase in number. These changes increase decomposition of organic matter in the bottom sediments (Bengtsson 1982). Phytoplankton behavior appears related to the degree and duration of acidification. After liming three acidified lakes in Sudbury, Ontario, the acid-tolerant dionflagellates declined severely and were replaced by acid intolerant chrysophytes which reestablished the phytoplankton biomass within a few months (Scheider et. al. 1975 b.). A less acidified lake in the same area, Nelson Lake, failed to change phytoplanktonic biomass (Yan and Dillon 1981). This is consistent with the cylinder experiments of Yan and Stokes (1978) in which phytoplankton biomass decreased shortly after liming in proportion to the increase of pH. Experience in Sweden confirms these points, however, in lake Lysevatten, Renberg and Hellberg (1982) found in analyzing sediment core samples that the diatoms present after liming were different from those which the lake had historically supported.

Zooplankton responded similarly to the phytoplankton, but they took longer to reestablish, owing to the slower reproductive cycles (Bengtsson et. al. 1980; Yan and Dillon 1981). The changes in taxa were from a predominance of cladocerans to a predominance of copepods (Hultberg and Andersson 1981; Yan and Dillon 1981).

Benthic invertebrates habitat may experience dramatic changes with liming, because substrate pH changed substantially. Certain benthic algal and sphagnum moss mats are severely damaged or eradicated (Bengtsson et. al. 1979; Hultberg and Andersson 1981; 1982). As expected, acid tolerant chironomids species suffer an almost immediate reduction in biomass following liming, but within two years less acid tolerant species had replaced the lost biomass (Hultberg and Andersson 1981). Crayfish populations respond positively to liming, occupying large areas of treated water (Bengtsson 1982).

The response of fish to liming is an extensively studied area of acid mitigation. The findings are almost universally favorable. Gunn and Keller (1980, 1981) achieved successful spawning of lake, brook and rainbow trout. Hultberg and Andersson (1981) reintroduced northern pike and brown trout in Swedish lakes. Bengtsson et. al. (1980) documented improved survival of Atlantic salmon in the Hogvadsan river system. Keller et. al. (1980) found improved water quality allowed reintroduced smallmouth bass to spawn successfully. However, fish mortality can occur if aluminum concentrations are high in relation to the volume of lime applied (Bengtsson 1982).

B. Massachusetts Experience:

In studying the impact of liming the Division chose to monitor water chemistry and fish populations.

In the initial evaluation of liming, Palermo (1974) noted that liming lasted at least four years with one exception. Fresh pond, Dennis, a dystrophic, cedar swamp pond barely responded to the addition of a thousand pounds of lime per acre. Thereafter, dystrophic ponds have not been limed. A subsequent analysis of Palermo's data, focusing on four kettle ponds (Little, Fearing, Schoolhouse and Sheep) and a drainage pond, (Wallum Lake), produced a wide range of information (Keller, memo). First, treating the ponds with one-half to one ton of agricultural lime per surface acre raised the pH by one to two units within two to six months (Appendix D). The total alkalinity and hardness increased two to three fold to a maximum of 20 ppm. Dissolved oxygen declined in the hypolimnion after liming. This hypolimnial deoxygenation increased for two to four years. Transparency responded variably but tended to slightly decrease. Heavy metals declined to unmeasurable levels, while calcium silica and magnesium increased a few parts per million. Sodium, potassium and cloride levels declined 50% at the extreme but generally did not change. These findings are consistent with the literature. A continuation of our Wallum lake study by Rhode Island (Guthrie 1982) showed the lake continued to function well after 11 years and two limings.

As stated in the history of liming activities, an early goal was to preserve trout ponds and facilitate trout fisheries. As Palermo noted (1974), both brown and rainbow trout could be stocked in the limed lakes without incurring acid induced mortalities. He also pointed out that stocking could be undertaken earlier, giving anglers more days of recreation. In a number of ponds on Cape Cod, liming has allowed small-mouth bass to successfully reproduce (Lindenberg, memo). Prior to liming Wallum lake, only adult brook trout (Salvelinus fontinalis) could be stocked; with liming, a trophy brown trout (Salmo trutta) fishery has been established which is supported by a forage population of alewives (Alosa pseudoharenous) (McLaughlin, pers. comm.). Previous attempts to establish a forage fish (Rainbow smelt, Osmerus mordax) had failed; alewife stocking was not even considered because the pH was so low.

V. Available Mitigation to Identified Impacts

The major impact associated with aquatic acidification is the loss of overall biological productivity of the system which often entails complete loss of important species such as sport fish and their associated food organisms.

The reduction of sulfur emissions will no doubt reduce the rate of acidification, hopefully to the point where natural buffering systems will be sufficient to cope with existing loads. Unfortunately the existing load of sulfate deposition exceeds the buffering capacity of many sensitive watersheds and will continue to be in excess for a number of years to come even with an immediate significant reduction in sulfate emissions. In order to preserve and protect sensitive waters from increasing acidification two types of mitigation are directed at enhancing the buffering capacity of sensitive watersheds.

The first is the direct addition of basic material (i.e. limestone - soda ash - quick lime), the second is the alteration of land management practices designed to increase the availability of natural buffers for the associated aquatic habitat.

In the case of base addition, much research and evaluation has been conducted. With respect to the latter it is primarily theory and modeling investigations that make the practice a potential mitigative strategy.

Unfortunately in the latter case, there must be an economic incentive to alter the present land use practice. Also there is the delayed response time that must be considered via this technique. When dealing with acidified and critical habitats the associated aquatic community under stress may not be able to survive the increase in acidity during the longer time interval of system response to altered land use practices.

With respect to recreational fisheries some investigators are striving to rear and select for more acid resistant strains of fish. While this technique may lend itself to high altitude brook trout only waters typical of some ponds in the Adirondack Mountains, it does not hold much promise for Massachusetts waters that host more diverse species communities.

It is precisely because of these major problems that the Division presently views the direct addition of basic material (limestone) as the only viable alternative to protect aquatic habitats from the effects of increasing acidification.

VI. Lake and Pond Selection Criteria

In selecting potential candidate waters in need of mitigative liming the Division will follow the decision pathway as shown in (Figure 2). The following explanations accompany the numerical decision points.

1) No lake or pond will be considered a candidate for mitigation unless the alkalinity is less than 2 ppm. At this point the pH may become unstable with a single storm event causing a decline of as much as one whole pH unit. Such instability may affect the reproductive success of aquatic organisms.

2) Only waters having legitimate public access will be considered for treatment with public funds. Additionally only ponds in excess of ten surface acres will be considered unless unique circumstances exist that can justify the expense of mitigative liming practices.

3) Dystrophic (natural bog waters) ponds will not be treated with lime. These are naturally acidic waters providing habitat and support for their own unique aquatic communities. As previously stated the intent of the mitigation program is not to alter existing communities but to preserve those threatened by significant change due to increasing acidification. Dystrophic lakes are frequently characterized as brown water lakes, high in humus, and low in nutrients.

4) Pond retention time must exceed one year for the lime to achieve any significant buffering. Refuge liming is an exception. This liming entails attempting to maintain suitable pH levels in only a portion of a lake for a limited duration in time and space. Such a practice may be justified when water bodies are excessively large or special protection for spawning and nursery grounds warrant such applications.

5) All candidate waters will have dissolved metal content analyzed. The metal of primary concern is aluminum, although mercury, zinc, copper and lead will also be screened. In many instances, where the pH is raised above 5.5, these metals become acutely toxic to existing fish populations prior to precipitating out. If existing Al content exceeds .2 ppm the water will not be limed.

6) If the lake bottom is extensively covered with mud and organic debris, it will be dropped from further consideration, or relegated to an experimental category (see section 8). Because most of the lime applied would be tied up with the bottom matter, greatly increasing the amount of lime required to neutralize the lake. Additionally, rapid neutralization and oxidation of bottom matter could cause significant depletions of dissolved oxygen content for a period of years.

7) Experience with liming in Massachusetts kettle lakes indicates that the application of one-half ton of ground agricultural limestone per surface acre; applied primarily within the 15 to 20 foot contour zone; effectively buffers additional acid inputs for at least four or five years. When the mean depth is less than or equal to eight feet or the maximum depth does not exceed 18 feet the lake will be treated with only one-quarter ton of limestone per surface area or other experimental dosage.

8) Ponds demonstrating high accumulations of organic material as described in section (6) may be placed in an experimental category and scheduled to receive a series of small lime applications over a number of years in order to safeguard against excessive oxygen depletions in stratified waters.

9) All waters scheduled to receive an application of limestone will first be screened for rare and endangered species by staff biologist from the Natural Heritage Section. Upon the identification of a rare or endangered species, their guidance and recommendations will determine whether or not a pond or lake will be treated with limestone.

10) As new methods of mitigating the harmful effects of acidification are described and evaluated either by our own research or that reported in scientific literature; the most cost effective methods will be applied where and when warranted.

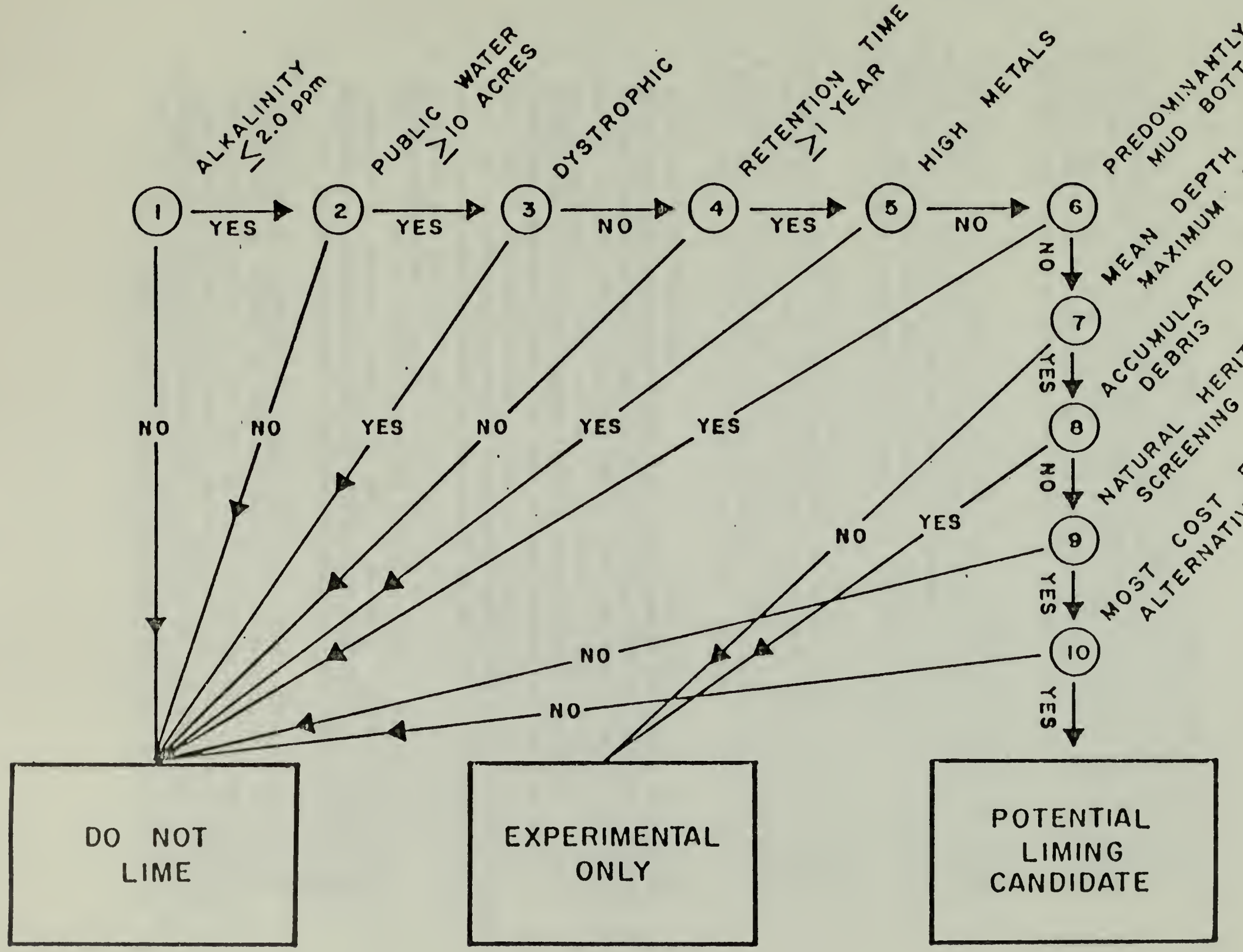


Figure 2. LIMING DECISION PATHWAY

VII. Additional Data and Research Needs

Many papers, workshops and symposia addressing the effects of mitigative liming have been conducted, presented, and published in recent years, the majority of these studies focus upon preserving or restoring aquatic communities associated with lake environments. Numerous streams and impoundments with retention time of less than one year are threatened and acidifying at accelerated rates. Unfortunately, they do not presently lend themselves to mitigative liming on a economical and/or ecological cost benefit ratio. Some new technologies currently being developed in Scandanavia may hold some promise for application in Massachusetts flowing waters. The Division has recently solicited research proposals aimed at developing effective methods to counteract stream and impoundment acidification.

Under certain conditions, a fishery may be severely stressed long before the total alkalinity drops below 2 ppm. This is particularly true of lakes having naturally high concentrations of heavy metals. In some other lakes, lacking metals, the total alkalinity may approach 0.0 ppm before the fishery is impacted. Mitigative liming is a costly undertaking it would be advantageous not to apply lime until the preliminary signs of stress in fish populations are evident. The search for suitable physiological indicators of acid induced stress in fish populations would aid greatly in the decision process regarding the application of lime consequently. The Division will soon be initiating an investigation by a research fish physiologist at the University of Massachusetts in Amherst.

When rare or endangered plant species are identified as being in association with an aquatic community which is a bonafied liming candidate, the potential impact of the lime application needs to be addressed. Where the potential impact is unknown research investigations will be undertaken to address the question. All information produced from these investigations will be published to guide others faced with the same or similar problems.

In some instances it is not practical to attempt to lime an entire body of water. Where unique spawning and nursery grounds are threatened by episodic acidity alterations (i.e. spring runoff) - refuge liming - liming of a certain location or locations during a critical time period will be investigated and evaluated. Initial investigations to protect smelt spawning in the Quabbin Reservoir or to assure successful smallmouth bass reproduction in soft water lakes are scheduled to commence during the spring of 1985.

Upon the completion of the Division funded Acid Rain Monitoring Project currently being conducted through the Massachusetts Water Resource Research Center, the Division will have the first complete screening of all state waters threatened by additional acidic input. The information gathered by this effort will serve as the starting point on the decision pathway as to whether or not to apply mitigative liming techniques; and serve as a baseline to evaluate mitigative techniques.

The Division is currently cooperating in investigations with the Division of Water Pollution Control and the Massachusetts Audubon Society which addresses the ecological impacts of liming typical Cape Cod kettle ponds (Appendix F)). Similar studies will be expanded to other bodies of water throughout the Commonwealth as we constantly attempt to document the effects of increasing acidification and effectiveness of current mitigative practices.

Finally the impact of liming upon potability of groundwater supplies needs to be addressed. Again, some information from the Scandanavian experience may be of assistance in ascertaining potential impacts in Massachusetts, however, investigations specifically addressing the Massachusetts situation may need to be undertaken. Water quality monitoring of wells lying in close association to limed waters should be undertaken.

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Appendix A

Executive Office of Environmental Affairs Scoping Statement and Environmental Notification Form

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

MICHAEL S. DUKAKIS
GOVERNOR

JAMES S. HOYTE
SECRETARY

CERTIFICATE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS

ON THE

ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAMES : Liming of Acidified Waters
Liming Great Pond (Truro)
Liming Baker Pond (Orleans)
Liming Schoolhouse Pond (Chatham)

PROJECT LOCATIONS : Statewide

EOEA NUMBERS : 5148, 5147, 5149, 5150

PROJECT PROPONENT : Division of Fisheries & Wildlife

DATE NOTICED IN MONITOR: April 9, 1984

Pursuant to M.G.L., Chapter 30, Section 62A and Sections 10.04(1) and 10.04(9) of the Regulations Governing the Implementation of the Massachusetts Environmental Policy Act, I hereby determine that EOEA 5148 does require the preparation of a Generic Environmental Impact Report. This Certificate establishes the scope for the Generic EIR, and also discusses conditions under which individual liming projects EOEA 5147 (Truro), EOEA 5149 (Orleans), and EOEA 5150 (Chatham) may proceed pending preparation and review of the Generic EIR.

The Generic Environmental Impact Report (GEIR) shall conform to MEPA regulations and shall address the following scope.

SCOPE

I. History of the liming program in Massachusetts.

II. Current status of Commonwealth water bodies.

III. Impact of Acidification of water bodies on the ecosystem.
a. Known from Literature.
b. Known from Massachusetts experience.

IV. Potential impacts of the Acidification control techniques.

a. Known from Literature.
b. Known from Massachusetts experience.

V. Identify and evaluate all available mitigation to the identified impacts.

VI. Describe the proposed state program including pond selection criteria and present the reasons for selecting the proposed program.

VII. Identify areas needing additional data and/or experimentation over the next few years.

VIII. The Final Generic EIR should contain and respond to all comments on the Draft Generic EIR. The Draft Generic EIR should evaluate and respond to points raised in comments on the ENF.

Individual liming projects in Truro, Chatham, and Orleans were reviewed simultaneously with review of the ENF for the Generic EIR. Preliminary data based on the literature indicate that planktonic organisms may decline on treatment for approximately two months, then to recover in numbers, but not necessarily in the same species. A similar recovery for benthic organisms may require two years for a similar recovery.

The Great Pond and Ryder Pond project (Truro) is designed to generate, over the next two years, an evaluation of the impacts on the pond ecosystem, and should proceed.

Baker Pond (Orleans) and Schoolhouse Pond (Truro) involve rare plant species. No one can predict the impact on these species at this point. Unless the species have a rather broad occurrence in the cape ponds, these two projects should wait until the reaction of the plants to changed pH and alkalinity can be determined. If a broader distribution of the plants is found to exist, one of the ponds may be limed for experimental purposes or prior to completion of the Generic EIR.

May 9, 1984
DATE

JAMES S. HOWE, SECRETARY

JSH/DS/dc

APPENDIX A
COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

ENVIRONMENTAL NOTIFICATION FORM

I. SUMMARY

A. Project Identification
1. Project Name Liming of Acidified Waters

2. Project Proponent MA Division of Fisheries & Wildlife
Address Field Headquarters, Westboro, MA 01581

B. Project Description: (City/Town(s) Statewide
1. Location within city/town or street address

2. Est. Commencement Date: September 1984 Est. Completion Date: Indefinite
Approx. Cost $ 100,-150,000/year/10 years Current Status of Project Design: 40 % Complete

C. Narrative Summary of Project
Describe project and give a description of the general project boundaries and the present use of the project area. (If necessary, use back of this page to complete summary).

The intent of this project is to prevent the deterioration of aquatic communities from the real threat of increased environmental acidification. Where threatened waters lend themselves to cost effective protective mitigation they will receive low doses of agricultural limestone where and when necessary to prevent significant acidification of the environment.

The primary intent is to preserve and protect the fish and wildlife resources presently occupying aquatic habitats that are threatened by increased loads of acidic precipitation commonly referred to as acid rain.

Copies of this may be obtained from:
Name: Fisheries Section Firm/Agency: MA Division of Fisheries & Wildlife
Address: Field Headquarters, Westboro, MA 01581 Phone No. (617) 366-4470

1979 THIS IS AN IMPORTANT NOTICE. COMMENT PERIOD IS LIMITED.
For Information, call (617) 727-5830

Use This Page to Complete Narrative, if necessary.

This project is one which is categorically included and therefore automatically requires preparation of an Environmental Impact Report: YES_____ NO__X__

D. Scoping (Complete Sections II and III first, before completing this section.)

1. Check those areas which would be important to examine in the event that an EIR is required for this project. This information is important so that significant areas of concern can be identified as early as possible, in order to expedite analysis and review.

	Construc-tion Impacts	Long Term Impacts		Construc-tion Impacts	Long Term Impacts
Open Space & Recreation			Mineral Resources		
Historical			Energy Use		
Archaeological			Water Supply & Use		
Fisheries & Wildlife		X	Water Pollution		X
Vegetation, Trees			Air Pollution		
Other Biological Systems		X	Noise		
Inland Wetlands		X	Traffic		
Coastal Wetlands or Beaches			Solid Waste		
Flood Hazard Areas			Aesthetics		
Chemicals, Hazardous Substances, High Risk Operations			Wind and Shadow		
			Growth Impacts		
Geologically Unstable Areas			Community/Housing and the Built Environment		
Agricultural Land					
Other (Specify)_____					

2. List the alternatives which you would consider to be feasible in the event an EIR is required.

The use of lime or other basic compound are the only alternatives currently available to mitigate the harmful effects of increased environmental acidification. It will be a long time before the source of harmful pollutants come under adequate control.

E. Has this project been filed with EOEA before? Yes _____ No X
If Yes, EOEA No. _____ EOEA Action? _____

F. Does this project fall under the jurisdiction of NEPA? Yes _____ No X
If Yes, which Federal Agency? _____ NEPA Status? _____

G. List the State or Federal agencies from which permits will be sought:

Agency Name	Type of Permit
None	

H. Will an Order of Conditions be required under the provisions of the Wetlands Protection Act (Chap. 131, Section 40)?
Yes X No _____ Individual lake filings will be required.
DEQE File No., if applicable: _____

I. List the agencies from which the proponent will seek financial assistance for this project:

Agency Name	Funding Amount
U.S. Fish and Wildlife Service	$75 - 100,000

II. PROJECT DESCRIPTION

A. Include an original 8½ x11 inch or larger section of the most recent U.S.G.S. 1:24,000 scale topographic map with the project area location and boundaries clearly shown. Include multiple maps if necessary for large projects. Include other maps, diagrams or aerial photos if the project cannot be clearly shown at U.S.G.S. scale. If available, attach a plan sketch of the proposed project.

B. State total area of project: Statewide (4,000 acres of water)
Estimate the number of acres (to the nearest 1/10 acre) directly affected that are currently:

1. Developed ..... ____ acres
2. Open Space/Woodlands/Recreation ____ acres
3. Wetlands ..... 400 acres
4. Floodplain ..... ____ acres
5. Coastal Area ..... ____ acres
6. Productive Resources
   - Agriculture ..... ____ acres
   - Forestry ..... ____ acres
   - Mineral Products ..... ____ acres

C. Provide the following dimensions, if applicable: Not Applicable

Length in miles _____ Number of Housing Units _____ Number of Stories _____

	Existing	Immediate Increase Due to Project
Number of Parking Spaces	_____	_____
Vehicle Trips to Project Site (average daily traffic)	_____	_____
Estimated Vehicle Trips past project site	_____	_____

D. If the proposed project will require any permit for access to local or state highways, please attach a sketch showing the location of the proposed driveway(s) in relation to the highway and to the general development plan; identifying all local and state highways abutting the development site; and indicating the number of lanes, pavement width, median strips and adjacent driveways on each abutting highway; and indicating the distance to the nearest intersection.

Not Applicable

III. ASSESSMENT OF POTENTIAL ADVERSE ENVIRONMENTAL IMPACTS

Instructions: Consider direct and indirect adverse impacts, including those arising from general construction and operations. For every answer explain why significant adverse impact is considered likely or unlikely to result.

Also, state the *source* of information or other basis for the answers supplied. If the source of the information, in part or in full, is not listed in the ENF, the preparing officer will be assumed to be the source of the information. Such environmental information should be acquired at least in part by field inspection.

A. Open Space and Recreation

1. Might the project affect the condition, use or access to any open space and/or recreation area?
   Yes _____ No X

   Explanation and Source:

B. Historic Resources

1. Might any site or structure of historic significance be affected by the project? Yes _____ No X

   Explanation and Source:

2. Might any archaeological site be affected by the project? Yes _____ No X

   Explanation and Source:

C. Ecological Effects

1. Might the project significantly affect fisheries or wildlife, especially any rare or endangered species?
   Yes X No _____

   Explanation and Source:

   The intent is to protect and preserve existing fish and wildlife resources. The Heritage Program will be consulted prior to liming each lake to evaluate potential impacts or rare or endangered species.

2. Might the project significantly affect vegetation, especially any rare or endangered species of plant?
   Yes _____ No X
   (Estimate approximate number of mature trees to be removed: _____)

   Explanation and Source:

   The effect may be positive or negative depending upon the species under consideration. Rare and endangered species will be identified by the Heritage Program. Their opinion will be included in the mitigation decision process.

3. Might the project alter or affect flood hazard areas, inland or coastal wetlands (e.g., estuaries, marshes, sand dunes and beaches, ponds, streams, rivers, fish runs, or shellfish beds)? Yes X No _____

   Explanation and Source:

   The effect on the wetlands may be positive or negative depending upon the species and situation. Regional wetlands specialists of D.E.Q.E. will be consulted whenever a wetlands impact appears possible.

4. Might the project affect shoreline erosion or accretion at the project site, downstream or in nearby coastal areas? Yes _____ No X

   Explanation and Source:

5. Might the project involve other geologically unstable areas? Yes _____ No X

   Explanation and Source:

D. Hazardous Substances

1. Might the project involve the use, transportation, storage, release, or disposal of potentially hazardous substances?
   Yes _____ No X

   Explanation and Source:

III. AS

E. Resource Conservation and Use

1. Might the project affect or eliminate land suitable for agricultural or forestry production?
Yes _____ No __X__
(Describe any present agricultural land use and farm units affected.)

Explanation and Source:

A.

2. Might the project directly affect the potential use or extraction of mineral or energy resources (e.g., oil, co sand & gravel, ores)? Yes _____ No __X__

Explanation and Source:

B.

3. Might the operation of the project result in any increased consumption of energy? Yes _____ No __X__

Explanation and Source:
(If applicable, describe plans for conserving energy resources.)

F. Water Quality and Quantity

1. Might the project result in significant changes in drainage patterns? Yes __X__ No _____

Explanation and Source:

There is a short-term reduction of transparency (20-30%) caused by algae utilizing the nutrients released by the lime, up to one year.

C. E
1

2. Might the project result in the introduction of pollutants into any of the following:
(a) Marine Waters ..... Yes _____ No X
(b) Surface Fresh Water Body ..... Yes _____ No X
(c) Ground Water ..... Yes _____ No X

Explain types and quantities of pollutants.

3. Will the project generate sanitary sewage? Yes _____ No X
   If Yes, Quantity: _____ gallons per day
   Disposal by: (a) Onsite septic systems ..... Yes _____ No _____
   (b) Public sewerage systems ..... Yes _____ No _____
   (c) Other means (describe) _____

4. Might the project result in an increase in paved or impervious surface over an aquifer recognized as an important present or future source of water supply? Yes _____ No X

   Explanation and Source:

5. Is the project in the watershed of any surface water body used as a drinking water supply?
   Yes X No _____
   Are there any public or private drinking water wells within a 1/2-mile radius of the proposed project?
   Yes X No _____

   Explanation and Source:

   Some of the acidified ponds are used as water supplies for towns or individuals. This is not a problem since E.P.A. and D.E.Q.E. recommend water supplies maintain a pH of 6.0 or higher. This project will raise the pH to between 6 and 6.5.

6. Might the operation of the project result in any increased consumption of water? Yes _____ No X
   Approximate consumption _____ gallons per day. Likely water source(s) _____

   Explanation and Source:

7. Does the project involve any dredging? Yes _____ No X
   If Yes, indicate:
   Quantity of material to be dredged _____
   Quality of material to be dredged _____
   Proposed method of dredging _____
   Proposed disposal sites _____
   Proposed season of year for dredging _____

   Explanation and Source:

G. Air Quality

1. Might the project affect the air quality in the project area or the immediately adjacent area?
   Yes _____ No _X_
   Describe type and source of any pollution emission from the project site._____

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any pollution emissions caused by the project, including construction dust? Yes _____ No _X_
   Explanation and Source:

3. Will access to the project area be primarily by automobile? Yes _____ No _X_
   Describe any special provisions now planned for pedestrian access, carpooling, buses and other mass transit.

H. Noise

1. Might the project result in the generation of noise? Yes _____ No _X_
   Explanation and Source:
   (Include any source of noise during construction or operation, e.g., engine exhaust, pile driving, traffic.)

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any noise caused by the project? Yes _____ No _X_
   Explanation and Source:

I. Solid Waste

1. Might the project generate solid waste? Yes _____ No X

Explanation and Source:
(Estimate types and approximate amounts of waste materials generated, e.g., industrial, domestic, hospital, sewage sludge, construction debris from demolished structures.)

J. Aesthetics

1. Might the project cause a change in the visual character of the project area or its environs?
Yes _____ No X

Explanation and Source:

2. Are there any proposed structures which might be considered incompatible with existing adjacent structures in the vicinity in terms of size, physical proportion and scale, or significant differences in land use?
Yes _____ No X

Explanation and Source:

3. Might the project impair visual access to waterfront or other scenic areas? Yes _____ No X

Explanation and Source:

K. Wind and Shadow

1. Might the project cause wind and shadow impacts on adjacent properties? Yes _____ No X

Explanation and Source:

IV. CONSISTENCY WITH PRESENT PLANNING

A. Describe any known conflicts or inconsistencies with current federal, state and local land use, transportation, open space, recreation and environmental plans and policies. Consult with local or regional planning authorities where appropriate.

There are no known conflicts. This is the only practical short-term solution to the problem.

V. FINDINGS AND CERTIFICATION

A. The notice of intent to file this form has been/will be published in the following newspaper(s):

(Name) Boston Globe	(Date) March 26, 1984
Worcester Telegram	March 26, 1984
Springfield Union	March 26, 1984

B. This form has been circulated to all agencies and persons as required by Appendix B.

3/12/84
Date

Peter H. Oatis
Signature of Responsible Officer or Project Proponent

Peter H. Oatis
Name (print or type)

Address Div. of Fisheries & Wildlife
Field Headquarters, Westboro, MA 01581
Telephone Number (617) 366-4470

3/12/84
Date

Joseph Bergin
Signature of person preparing ENF (if different from above)

Joseph Bergin
Name (print or type)

Address Div. of Fisheries & Wildlife
Field Headquarters, Westboro, MA 01581
Telephone Number (617) 366-4470

ENVIRONMENTAL NOTIFICATION FORM

I. SUMMARY

A. Project Identification

1. Project Name: Liming Acidified Waters
Baker Pond

2. Project Proponent: Division of Fisheries & Wildlife
Address: Field Headquarters, Westboro, MA 01581

B. Project Description: (City/Town(s): Orleans

1. Location within city/town or street address: Baker Pond

2. Est. Commencement Date: September 16, 1985 Est. Completion Date: September 16, 1985
Approx. Cost $: 500 Current Status of Project Design: 100 % Complete

C. Narrative Summary of Project

Describe project and give a description of the general project boundaries and the present use of the project area. (If necessary, use back of this page to complete summary).

District personnel will apply 16 tons of lime to the entire surface of the pond by boat to offset the impact of acid rain. The lime used will be agricultural lime supplied by Conkline lime of Rhode Island.

Copies of this may be obtained from:
Name: Fisheries Section Firm/Agency: Division of Fisheries & Wildlife
Address: Field Headquarters, Westboro, MA 01581 Phone No. (617) 366-4470

1979 THIS IS AN IMPORTANT NOTICE. COMMENT PERIOD IS LIMITED.
For Information, call (617) 727-5830

Use This Page to Complete Narrative, if necessary.

This project is one which is categorically included and therefore automatically requires preparation of an Environmental Impact Report: YES_____ NO__X_____

D. Scoping (Complete Sections II and III first, before completing this section.)

1. Check those areas which would be important to examine in the event that an EIR is required for this project. This information is important so that significant areas of concern can be identified as early as possible, in order to expedite analysis and review.

	Construction Impacts	Long Term Impacts		Construction Impacts	Long Term Impacts
Open Space & Recreation			Mineral Resources		
Historical			Energy Use		
Archaeological			Water Supply & Use		
Fisheries & Wildlife		X	Water Pollution		
Vegetation, Trees			Air Pollution		
Other Biological Systems		X	Noise		
Inland Wetlands		X	Traffic		
Coastal Wetlands or Beaches			Solid Waste		
Flood Hazard Areas			Aesthetics		
Chemicals, Hazardous Substances, High Risk Operations			Wind and Shadow		
			Growth Impacts		
Geologically Unstable Areas			Community/Housing and the Built Environment		
Agricultural Land					
Other (Specify)_____					

2. List the alternatives which you would consider to be feasible in the event an EIR is required.

E. Has this project been filed with EOEA before? Yes _____ No X
If Yes, EOEA No. _____ EOEA Action? _____

F. Does this project fall under the jurisdiction of NEPA? Yes _____ No X
If Yes, which Federal Agency? _____ NEPA Status? _____

G. List the State or Federal agencies from which permits will be sought:

Agency Name	Type of Permit
None	

H. Will an Order of Conditions be required under the provisions of the Wetlands Protection Act (Chap. 131, Section 40)?
Yes X No _____
DEQE File No., if applicable: SE 54280

I. List the agencies from which the proponent will seek financial assistance for this project:

Agency Name	Funding Amount
U.S. Fish & Wildlife Service	$350

II. PROJECT DESCRIPTION

A. Include an original 8½ x11 inch or larger section of the most recent U.S.G.S. 1:24,000 scale topographic map with the project area location and boundaries clearly shown. Include multiple maps if necessary for large projects. Include other maps, diagrams or aerial photos if the project cannot be clearly shown at U.S.G.S. scale. If available, attach a plan sketch of the proposed project.

B. State total area of project: 32
Estimate the number of acres (to the nearest 1/10 acre) directly affected that are currently:

1. Developed ..... ____ acres
2. Open Space/Woodlands/Recreation 32 acres
3. Wetlands ..... ____ acres
4. Floodplain ..... ____ acres
5. Coastal Area ..... ____ acres
6. Productive Resources
   - Agriculture ..... ____ acres
   - Forestry ..... ____ acres
   - Mineral Products ..... ____ acres

C. Provide the following dimensions, if applicable:
Length in miles _____ Number of Housing Units _____ Number of Stories _____

	Existing	Immediate Increase Due to Project
Number of Parking Spaces	_____	0
Vehicle Trips to Project Site (average daily traffic)	_____	0
Estimated Vehicle Trips past project site	_____	0

D. If the proposed project will require any permit for access to local or state highways, please attach a sketch showing the location of the proposed driveway(s) in relation to the highway and to the general development plan; identifying all local and state highways abutting the development site; and indicating the number of lanes, pavement width, median strips and adjacent driveways on each abutting highway; and indicating the distance to the nearest intersection.

III. ASSESSMENT OF POTENTIAL ADVERSE ENVIRONMENTAL IMPACTS

Instructions: Consider direct and indirect adverse impacts, including those arising from general construction and operations. For every answer explain why significant adverse impact is considered likely or unlikely to result.

Also, state the *source* of information or other basis for the answers supplied. If the source of the information, in part or in full, is not listed in the ENF, the preparing officer will be assumed to be the source of the information. Such environmental information should be acquired at least in part by field inspection.

A. Open Space and Recreation

1. Might the project affect the condition, use or access to any open space and/or recreation area?
   Yes _____ No _X_

   Explanation and Source:

The goal is to protect the pond ecology for recreational activity. Based on over 20 years experience.

B. Historic Resources

1. Might any site or structure of historic significance be affected by the project? Yes _____ No _X_

   Explanation and Source:

None present (pond surface)

2. Might any archaeological site be affected by the project? Yes _____ No _X_

   Explanation and Source:

None present (pond surface)

C. Ecological Effects

1. Might the project significantly affect fisheries or wildlife, especially any rare or endangered species?
   Yes _X_ No _____

   Explanation and Source:

While the objective is to protect the pond's ecology, some segments will be adversely impacted by the release of lime, namely benthic invertebrates and zooplankton. See feasibility study to utilize liming as a technique to mitigate surface water acidification. Fraser Etal. 1982. Electric Power Research Institute.

2. Might the project significantly affect vegetation, especially any rare or endangered species of plant?
   Yes _____ No _____ Unknown
   (Estimate approximate number of mature trees to be removed: _____0_____)

   Explanation and Source:

The Heritage Program indicated there is one rare plant species present. The impact of liming is unknown.

3. Might the project alter or affect flood hazard areas, inland or coastal wetlands (e.g., estuaries, marshes, sand dunes and beaches, ponds, streams, rivers, fish runs, or shellfish beds)? Yes _____ No _____

   Explanation and Source:

4. Might the project affect shoreline erosion or accretion at the project site, downstream or in nearby coastal areas? Yes _____ No _____

   Explanation and Source:

5. Might the project involve other geologically unstable areas? Yes _____ No _____

   Explanation and Source:

D. Hazardous Substances

1. Might the project involve the use, transportation, storage, release, or disposal of potentially hazardous substances?
   Yes _____ No _____

   Explanation and Source:

E. Resource Conservation and Use

1. Might the project affect or eliminate land suitable for agricultural or forestry production?
Yes _____ No X
(Describe any present agricultural land use and farm units affected.)

Explanation and Source:

Ponds are seldom farmed and the water is not used for irrigation.

2. Might the project directly affect the potential use or extraction of mineral or energy resources (e.g., oil, coal, sand & gravel, ores)? Yes _____ No X

Explanation and Source:

No mining being done in this area and liming would only have a positive effect.

3. Might the operation of the project result in any increased consumption of energy? Yes X No _____

Explanation and Source:
(If applicable, describe plans for conserving energy resources.)

If the fishery is restored, fishermen may drive a few more miles to go fishing.

F. Water Quality and Quantity

1. Might the project result in significant changes in drainage patterns? Yes X No _____

Explanation and Source:

The liming will change water quality from severely acidic with very low metal and nutrients to a slightly acidic pond possessing low metal and nutrients. (Federal Aid DJ Report F36R)

2. Might the project result in the introduction of pollutants into any of the following:

(a) Marine Waters	Yes _____	No X
(b) Surface Fresh Water Body	Yes X	No _____
(c) Ground Water	Yes _____	No X

Explain types and quantities of pollutants.

The lime will be spread on the surface of the lake; some might consider the lime a pollutant while we view the acid rain as the real pollutant.

3. Will the project generate sanitary sewage? Yes _____ No X

If Yes, Quantity: _____ gallons per day

Disposal by: (a) Onsite septic systems ..... Yes _____ No X

(b) Public sewerage systems ..... Yes _____ No X

(c) Other means (describe)_____

None

4. Might the project result in an increase in paved or impervious surface over an aquifer recognized as an important present or future source of water supply? Yes _____ No _____

Explanation and Source:

Not applicable

5. Is the project in the watershed of any surface water body used as a drinking water supply?
Yes _____ No X

Are there any public or private drinking water wells within a 1/2-mile radius of the proposed project?
Yes _____ No _____

Explanation and Source:

There are 10 private residences within a ½ mile radius, most have private wells. No impact is anticipated since the lime will be complexed out within a few feet of groundwater.

6. Might the operation of the project result in any increased consumption of water? Yes _____ No X

Approximate consumption _____ gallons per day. Likely water source(s)_____

Explanation and Source:

Not applicable

7. Does the project involve any dredging? Yes _____ No X

If Yes, indicate:

Quantity of material to be dredged_____

Quality of material to be dredged_____

Proposed method of dredging_____

Proposed disposal sites_____

Proposed season of year for dredging_____

Explanation and Source:

None

G. Air Quality

1. Might the project affect the air quality in the project area or the immediately adjacent area?
   Yes _____ No X
   Describe type and source of any pollution emission from the project site._____

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any pollution emissions caused by the project, including construction dust? Yes _____ No X
   Explanation and Source:

3. Will access to the project area be primarily by automobile? Yes X No _____
   Describe any special provisions now planned for pedestrian access, carpooling, buses and other mass transit.

   Since only miniscule changes in utilization will occur, present facilities are sufficient.

H. Noise

1. Might the project result in the generation of noise? Yes _____ No X
   Explanation and Source:
   (Include any source of noise during construction or operation, e.g., engine exhaust, pile driving, traffic.)

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any noise caused by the project? Yes _____ No X
   Explanation and Source:

I. Solid Waste

1. Might the project generate solid waste? Yes _____ No __X__

Explanation and Source:
(Estimate types and approximate amounts of waste materials generated, e.g., industrial, domestic, hospital, sewage sludge, construction debris from demolished structures.)

None

J. Aesthetics

1. Might the project cause a change in the visual character of the project area or its environs?
Yes __X__ No _____

Explanation and Source:

After liming, the released nutrients may prompt an increase of the algal population, reducing transparency from 15 feet to 12 feet. (Federal Aid DJ Report F36R).

2. Are there any proposed structures which might be considered incompatible with existing adjacent structures in the vicinity in terms of size, physical proportion and scale, or significant differences in land use?
Yes _____ No __X__

Explanation and Source:

None

3. Might the project impair visual access to waterfront or other scenic areas? Yes _____ No __X__

Explanation and Source:

None

K. Wind and Shadow

1. Might the project cause wind and shadow impacts on adjacent properties? Yes _____ No __X__

Explanation and Source:

None

IV. CONSISTENCY WITH PRESENT PLANNING

A. Describe any known conflicts or inconsistencies with current federal, state and local land use, transportation, open space, recreation and environmental plans and policies. Consult with local or regional planning authorities where appropriate.

Since the Reagan Administration denies the impact of acid rain, this treatment conflicts with their view. Otherwise this action is entirely appropriate.

V. FINDINGS AND CERTIFICATION

A. The notice of intent to file this form has been/will be published in the following newspaper(s):

(Name) Cape Cod Times (Date) 3/15/84

_____ _____

_____ _____

B. This form has been circulated to all agencies and persons as required by Appendix B.

3/12/84 Joseph Bergin
Date Signature of Responsible Officer or Project Proponent

Joseph Bergin
Name (print or type)

Address Div. of Fisheries & Wildlife
Field Headquarters, Westboro, MA 01581
Telephone Number (617) 366-4470

_____ _____
Date Signature of person preparing ENF (if different from above)

_____
Name (print or type)

Address _____

_____

Telephone Number _____

APPENDIX A
COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

ENVIRONMENTAL NOTIFICATION FORM

I. SUMMARY

A. Project Identification
1. Project Name Liming Acidified Waters
A) Great Pond
2. Project Proponent Division of Fisheries & Wildlife
Address Field Headquarters, Westboro, MA 01581

B. Project Description: (City/Town(s) A) Truro
1. Location within city/town or street address Great Pond

2. Est. Commencement Date: March 1, 1985 Est. Completion Date: March 2, 1985
Approx. Cost $ 600 Current Status of Project Design: 100 % Complete

C. Narrative Summary of Project
Describe project and give a description of the general project boundaries and the present use of the project area. (If necessary, use back of this page to complete summary).

District personnel will apply 8 tons of lime to the entire surface of the pond by boat to offset the impact of acid rain. The lime used will be agricultural lime supplied by Conkline lime of Rhode Island.

Copies of this may be obtained from:
Name: Fisheries Section Firm/Agency: Division of Fisheries & Wildlife
Address: Field Headquarters, Westboro, MA 01581 Phone No. (617) 366-4470

THIS IS AN IMPORTANT NOTICE. COMMENT PERIOD IS LIMITED.
For Information, call (617) 727-5830

Use This Page to Complete Narrative, if necessary.

This project is one which is categorically included and therefore automatically requires preparation of an Environmental Impact Report: YES_____ NO__X__

D. Scoping (Complete Sections II and III first, before completing this section.)

1. Check those areas which would be important to examine in the event that an EIR is required for this project. This information is important so that significant areas of concern can be identified as early as possible, in order to expedite analysis and review.

	Construc-tion Impacts	Long Term Impacts		Construc-tion Impacts	Long Term Impacts
Open Space & Recreation			Mineral Resources		
Historical			Energy Use		
Archaeological			Water Supply & Use		
Fisheries & Wildlife		X	Water Pollution		
Vegetation, Trees			Air Pollution		
Other Biological Systems		X	Noise		
Inland Wetlands		X	Traffic		
Coastal Wetlands or Beaches			Solid Waste		
Flood Hazard Areas			Aesthetics		
Chemicals, Hazardous Substances, High Risk Operations			Wind and Shadow		
			Growth Impacts		
Geologically Unstable Areas			Community/Housing and the Built Environment		
Agricultural Land					
Other (Specify)_____					

2. List the alternatives which you would consider to be feasible in the event an EIR is required.

E. Has this project been filed with EOEA before? Yes _____ No X
If Yes, EOEA No. _____ EOEA Action? _____

F. Does this project fall under the jurisdiction of NEPA? Yes _____ No X
If Yes, which Federal Agency? _____ NEPA Status? _____

G. List the State or Federal agencies from which permits will be sought:

Agency Name	Type of Permit
None	

H. Will an Order of Conditions be required under the provisions of the Wetlands Protection Act (Chap. 131, Section 40)?
Yes X No _____
DEQE File No., if applicable: SE 75-87

I. List the agencies from which the proponent will seek financial assistance for this project:

Agency Name	Funding Amount
U.S. Fish and Wildlife	$400

II. PROJECT DESCRIPTION

A. Include an original 8½ x11 inch or larger section of the most recent U.S.G.S. 1:24,000 scale topographic map with the project area location and boundaries clearly shown. Include multiple maps if necessary for large projects. Include other maps, diagrams or aerial photos if the project cannot be clearly shown at U.S.G.S. scale. If available, attach a plan sketch of the proposed project.

B. State total area of project: 17
Estimate the number of acres (to the nearest 1/10 acre) directly affected that are currently:

1. Developed ..... ___ acres
2. Open Space/Woodlands/Recreation 17 acres
3. Wetlands ..... 2 acres
4. Floodplain ..... ___ acres
5. Coastal Area ..... ___ acres
6. Productive Resources
   - Agriculture ..... ___ acres
   - Forestry ..... ___ acres
   - Mineral Products ..... ___ acres

C. Provide the following dimensions, if applicable:

Length in miles _____ Number of Housing Units _____ Number of Stories _____

	Existing	Immediate Increase Due to Project
Number of Parking Spaces	_____	_____
Vehicle Trips to Project Site (average daily traffic)	2	0
Estimated Vehicle Trips past project site	_____	_____

D. If the proposed project will require any permit for access to local or state highways, please attach a sketch showing the location of the proposed driveway(s) in relation to the highway and to the general development plan; identifying all local and state highways abutting the development site; and indicating the number of lanes, pavement width, median strips and adjacent driveways on each abutting highway; and indicating the distance to the nearest intersection.

III. ASSESSMENT OF POTENTIAL ADVERSE ENVIRONMENTAL IMPACTS

Instructions: Consider direct and indirect adverse impacts, including those arising from general construction and operations. For every answer explain why significant adverse impact is considered likely or unlikely to result.

Also, state the *source* of information or other basis for the answers supplied. If the source of the information, in part or in full, is not listed in the ENF, the preparing officer will be assumed to be the source of the information. Such environmental information should be acquired at least in part by field inspection.

A. Open Space and Recreation

1. Might the project affect the condition, use or access to any open space and/or recreation area?
   Yes _____ No X

   Explanation and Source:

   The goal is to protect the pond ecology for recreational activity. Based on over 20 years experience.

B. Historic Resources

1. Might any site or structure of historic significance be affected by the project? Yes _____ No X

   Explanation and Source:

   None present (pond surface)

2. Might any archaeological site be affected by the project? Yes _____ No X

   Explanation and Source:

   None present (pond surface)

C. Ecological Effects

1. Might the project significantly affect fisheries or wildlife, especially any rare or endangered species?
   Yes X No _____

   Explanation and Source:

   While the objective is to protect the pond's ecology, some segments will be adversely impacted by the release of lime, namely benthic invertebrates and zooplankton. See feasibility study to utilize liming as a technique to mitigate surface water acidification. Fraser Etal. 1982. Electric Power Research Institute.

2. Might the project significantly affect vegetation, especially any rare or endangered species of plant?
   Yes _____ No _____
   (Estimate approximate number of mature trees to be removed: ____0____)

   Explanation and Source:

The Massachusetts Heritage Program indicated there were 0 rare and 0 endangered plants present. The impact of liming upon these plants is unknown.

3. Might the project alter or affect flood hazard areas, inland or coastal wetlands (e.g., estuaries, marshes, sand dunes and beaches, ponds, streams, rivers, fish runs, or shellfish beds)? Yes _____ No __X__

   Explanation and Source:

Liming cannot impact this.

4. Might the project affect shoreline erosion or accretion at the project site, downstream or in nearby coastal areas? Yes _____ No __X__

   Explanation and Source:

No action involving liming will impact erosion.

5. Might the project involve other geologically unstable areas? Yes _____ No __X__

   Explanation and Source:

Ponds are geologically stable.

D. Hazardous Substances

1. Might the project involve the use, transportation, storage, release, or disposal of potentially hazardous substances?
   Yes _____ No __X__

   Explanation and Source:

Limestone consists of CaO, silica, and trace amounts of complexed metals.

E. Resource Conservation and Use

1. Might the project affect or eliminate land suitable for agricultural or forestry production?
Yes _____ No X
(Describe any present agricultural land use and farm units affected.)

Explanation and Source:

Ponds are seldom farmed and the water is not used for irrigation.

2. Might the project directly affect the potential use or extraction of mineral or energy resources (e.g., oil, coal, sand & gravel, ores)? Yes _____ No X

Explanation and Source:

No mining being done in this area and liming would only have a positive effect.

3. Might the operation of the project result in any increased consumption of energy? Yes X No _____

Explanation and Source:
(If applicable, describe plans for conserving energy resources.)

If the fishery is restored, fishermen may drive a few more miles to go fishing.

F. Water Quality and Quantity

1. Might the project result in significant changes in drainage patterns? Yes X No _____

Explanation and Source:

The liming will change water quality from severely acidic with very low metal and nutrients to a slightly acidic pond possessing low metal and nutrients. (Federal Aid DJ Report F36R)

2. Might the project result in the introduction of pollutants into any of the following:

(a) Marine Waters	Yes _____	No X
(b) Surface Fresh Water Body	Yes X	No _____
(c) Ground Water	Yes _____	No X

Explain types and quantities of pollutants.

The lime will be spread on the surface of the lake; some might consider the lime a pollutant while we view the acid rain as the real pollutant.

3. Will the project generate sanitary sewage? Yes ____ No X
   If Yes, Quantity: _____ gallons per day
   Disposal by: (a) Onsite septic systems ..... Yes ____ No X
   (b) Public sewerage systems ..... Yes ____ No X
   (c) Other means (describe) _____

   None

4. Might the project result in an increase in paved or impervious surface over an aquifer recognized as an important present or future source of water supply? Yes ____ No X

   Explanation and Source:

   Not applicable

5. Is the project in the watershed of any surface water body used as a drinking water supply?
   Yes ____ No X
   Are there any public or private drinking water wells within a 1/2-mile radius of the proposed project?
   Yes X No ____

   Explanation and Source:

   There are 20 private residences within a ½ mile radius, most have private wells. No impact is anticipated since the lime will be complexed out in a few feet of groundwater.

6. Might the operation of the project result in any increased consumption of water? Yes ____ No X
   Approximate consumption _____ gallons per day. Likely water source(s) _____

   Explanation and Source:

   Not applicable

7. Does the project involve any dredging? Yes ____ No X
   If Yes, indicate:
   Quantity of material to be dredged _____
   Quality of material to be dredged _____
   Proposed method of dredging _____
   Proposed disposal sites _____
   Proposed season of year for dredging _____

   Explanation and Source:

   None

G. Air Quality

1. Might the project affect the air quality in the project area or the immediately adjacent area?
   Yes _____ No X
   Describe type and source of any pollution emission from the project site._____

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any pollution emissions caused by the project, including construction dust? Yes _____ No X

   Explanation and Source:

3. Will access to the project area be primarily by automobile? Yes X No _____
   Describe any special provisions now planned for pedestrian access, carpooling, buses and other mass transit.

   Since only miniscule changes in utilization will occur, present facilities are sufficient.

H. Noise

1. Might the project result in the generation of noise? Yes _____ No X

   Explanation and Source:
   (Include any source of noise during construction or operation, e.g., engine exhaust, pile driving, traffic.)

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any noise caused by the project? Yes _____ No X

   Explanation and Source:

I. Solid Waste

1. Might the project generate solid waste? Yes _____ No X

Explanation and Source:
(Estimate types and approximate amounts of waste materials generated, e.g., industrial, domestic, hospital, sewage sludge, construction debris from demolished structures.)

None

J. Aesthetics

1. Might the project cause a change in the visual character of the project area or its environs?
Yes X No _____

Explanation and Source:

After liming, the released nutrients may prompt an increase of the algal population, reducing transparency from 18 feet to 12 feet. (Federal Aid DJ Report F36R)

2. Are there any proposed structures which might be considered incompatible with existing adjacent structures in the vicinity in terms of size, physical proportion and scale, or significant differences in land use?
Yes _____ No X

Explanation and Source:

None

3. Might the project impair visual access to waterfront or other scenic areas? Yes _____ No X

Explanation and Source:

None

K. Wind and Shadow

1. Might the project cause wind and shadow impacts on adjacent properties? Yes _____ No X

Explanation and Source:

None

IV. CONSISTENCY WITH PRESENT PLANNING

A. Describe any known conflicts or inconsistencies with current federal, state and local land use, transportation, open space, recreation and environmental plans and policies. Consult with local or regional planning authorities where appropriate.

Since the Reagan Administration denies the impact of acid rain, this treatment conflicts with their view. Otherwise this action is entirely appropriate.

V. FINDINGS AND CERTIFICATION

A. The notice of intent to file this form has been/will be published in the following newspaper(s):

(Name) Cape Cod Times (Date) 3/15/84

B. This form has been circulated to all agencies and persons as required by Appendix B.

3/12/84
Date

Joseph Bergin
Signature of Responsible Officer or Project Proponent

Joseph Bergin
Name (print or type)

Address Div. of Fisheries & Wildlife
Field Headquarters, Westboro, MA 01581
Telephone Number (617) 366-4470

Date

Signature of person preparing ENF (if different from above)

Name (print or type)

Address

Telephone Number

APPENDIX A
COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

ENVIRONMENTAL NOTIFICATION FORM

I. SUMMARY

A. Project Identification
1. Project Name Liming Acidified Waters
Schoolhouse Pond
2. Project Proponent Division of Fisheries & Wildlife
Address Field Headquarters, Westboro, MA 01581

B. Project Description: (City/Town(s) Chatham
1. Location within city/town or street address Schoolhouse Pond
2. Est. Commencement Date: September 15, 1984 Est. Completion Date: September 16,1984
Approx. Cost $ 350 Current Status of Project Design: 100 % Complete

C. Narrative Summary of Project
Describe project and give a description of the general project boundaries and the present use of the project area. (If necessary, use back of this page to complete summary).

District personnel will apply 10 tons of lime to the entire surface of the pond by boat to offset the impact of acid rain. The lime used will be agricultural lime supplied by Conkline lime of Rhode Island.

Copies of this may be obtained from:
Name: Fisheries Section Firm/Agency: Division of Fisheries & Wildlife
Address: Field Headquarters, Westboro, MA 01581 Phone No. (617) 366-4470

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For Information, call (617) 727-5830

Use This Page to Complete Narrative, if necessary.

This project is one which is categorically included and therefore automatically requires preparation of an Environmental Impact Report: YES_____ NO__X__

D. Scoping (Complete Sections II and III first, before completing this section.)

1. Check those areas which would be important to examine in the event that an EIR is required for this project. This information is important so that significant areas of concern can be identified as early as possible, in order to expedite analysis and review.

	Construction Impacts	Long Term Impacts		Construction Impacts	Long Term Impacts
Open Space & Recreation			Mineral Resources		
Historical			Energy Use		
Archaeological			Water Supply & Use		
Fisheries & Wildlife		X	Water Pollution		
Vegetation, Trees			Air Pollution		
Other Biological Systems		X	Noise		
Inland Wetlands		X	Traffic		
Coastal Wetlands or Beaches			Solid Waste		
Flood Hazard Areas			Aesthetics		
Chemicals, Hazardous Substances, High Risk Operations			Wind and Shadow		
			Growth Impacts		
Geologically Unstable Areas			Community/Housing and the Built Environment		
Agricultural Land					
Other (Specify)_____					

2. List the alternatives which you would consider to be feasible in the event an EIR is required.

E. Has this project been filed with EOEA before? Yes _____ No X
If Yes, EOEA No. _____ EOEA Action? _____

F. Does this project fall under the jurisdiction of NEPA? Yes _____ No X
If Yes, which Federal Agency? _____ NEPA Status? _____

G. List the State or Federal agencies from which permits will be sought:

Agency Name	Type of Permit
None	

H. Will an Order of Conditions be required under the provisions of the Wetlands Protection Act (Chap. 131, Section 40)?
Yes X No _____
DEQE File No., if applicable: SE 10-394

I. List the agencies from which the proponent will seek financial assistance for this project:

Agency Name	Funding Amount
U.S. Fish & Wildlife	$275

II. PROJECT DESCRIPTION

A. Include an original 8½ x11 inch or larger section of the most recent U.S.G.S. 1:24,000 scale topographic map with the project area location and boundaries clearly shown. Include multiple maps if necessary for large projects. Include other maps, diagrams or aerial photos if the project cannot be clearly shown at U.S.G.S. scale. If available, attach a plan sketch of the proposed project.

B. State total area of project: 21
Estimate the number of acres (to the nearest 1/10 acre) directly affected that are currently:

1. Developed ..... ____ acres
2. Open Space/Woodlands/Recreation 21 acres
3. Wetlands ..... ____ acres
4. Floodplain ..... ____ acres
5. Coastal Area ..... ____ acres
6. Productive Resources
   - Agriculture ..... ____ acres
   - Forestry ..... ____ acres
   - Mineral Products ..... ____ acres

C. Provide the following dimensions, if applicable:
Length in miles _____ Number of Housing Units _____ Number of Stories _____

	Existing	Immediate Increase Due to Project
Number of Parking Spaces	_____	0
Vehicle Trips to Project Site (average daily traffic)	_____	0
Estimated Vehicle Trips past project site	_____	0

D. If the proposed project will require any permit for access to local or state highways, please attach a sketch showing the location of the proposed driveway(s) in relation to the highway and to the general development plan; identifying all local and state highways abutting the development site; and indicating the number of lanes, pavement width, median strips and adjacent driveways on each abutting highway; and indicating the distance to the nearest intersection.

III. ASSESSMENT OF POTENTIAL ADVERSE ENVIRONMENTAL IMPACTS

Instructions: Consider direct and indirect adverse impacts, including those arising from general construction and operations. For every answer explain why significant adverse impact is considered likely or unlikely to result.

Also, state the *source* of information or other basis for the answers supplied. If the source of the information, in part or in full, is not listed in the ENF, the preparing officer will be assumed to be the source of the information. Such environmental information should be acquired at least in part by field inspection.

A. Open Space and Recreation

1. Might the project affect the condition, use or access to any open space and/or recreation area?
   Yes _____ No _X_

   Explanation and Source:

The goal is to protect the pond ecology for recreational activity. Based on over 20 years experience.

B. Historic Resources

1. Might any site or structure of historic significance be affected by the project? Yes _____ No _X_

   Explanation and Source:

None present (pond surface)

2. Might any archaeological site be affected by the project? Yes _____ No _X_

   Explanation and Source:

None present (pond surface)

C. Ecological Effects

1. Might the project significantly affect fisheries or wildlife, especially any rare or endangered species?
   Yes _X_ No _____

   Explanation and Source:

While the objective is to protect the pond's ecology, some segments will be adversely impacted by the release of lime, namely benthic invertebrates and zooplankton. See feasibility study to utilize liming as a technique to mitigate surface water acidification. Fraser Etal. 1982. Electric Power Research Institute.

2. Might the project significantly affect vegetation, especially any rare or endangered species of plant?
   Yes _____ No _____ Unknown
   (Estimate approximate number of mature trees to be removed: ____0_____)

   Explanation and Source:

   The Heritage Program indicated there are 2 rare plant species present. The impact of liming is unknown.

3. Might the project alter or affect flood hazard areas, inland or coastal wetlands (e.g., estuaries, marshes, sand dunes and beaches, ponds, streams, rivers, fish runs, or shellfish beds)? Yes _____ No _____

   Explanation and Source:

4. Might the project affect shoreline erosion or accretion at the project site, downstream or in nearby coastal areas? Yes _____ No _____

   Explanation and Source:

5. Might the project involve other geologically unstable areas? Yes _____ No _____

   Explanation and Source:

D. Hazardous Substances

1. Might the project involve the use, transportation, storage, release, or disposal of potentially hazardous substances?
   Yes _____ No _____

   Explanation and Source:

E. Resource Conservation and Use

1. Might the project affect or eliminate land suitable for agricultural or forestry production?
Yes _____ No X
(Describe any present agricultural land use and farm units affected.)

Explanation and Source:

Ponds are seldom farmed and the water is not used for irrigation.

2. Might the project directly affect the potential use or extraction of mineral or energy resources (e.g., oil, coal, sand & gravel, ores)? Yes _____ No X

Explanation and Source:

No mining being done in this area and liming would only have a positive effect.

3. Might the operation of the project result in any increased consumption of energy? Yes X No _____

Explanation and Source:
(If applicable, describe plans for conserving energy resources.)

If the fishery is restored, fishermen may drive a few more miles to go fishing.

F. Water Quality and Quantity

1. Might the project result in significant changes in drainage patterns? Yes X No _____

Explanation and Source:

The liming will change water quality from severely acidic with very low metal and nutrients to a slightly acidic pond possessing low metal and nutrients. (Federal Aid DJ Report F36R)

2. Might the project result in the introduction of pollutants into any of the following:

(a) Marine Waters	Yes _____	No X
(b) Surface Fresh Water Body	Yes X	No _____
(c) Ground Water	Yes _____	No X

Explain types and quantities of pollutants.

The lime will be spread on the surface of the lake; some might consider the lime a pollutant while we view the acid rain as the real pollutant.

3. Will the project generate sanitary sewage? Yes _____ No X

If Yes, Quantity: _____ gallons per day

Disposal by: (a) Onsite septic systems ..... Yes _____ No X

(b) Public sewerage systems ..... Yes _____ No X

(c) Other means (describe)_____

4. Might the project result in an increase in paved or impervious surface over an aquifer recognized as an important present or future source of water supply? Yes _____ No X

Explanation and Source:

5. Is the project in the watershed of any surface water body used as a drinking water supply?

Yes _____ No X

Are there any public or private drinking water wells within a 1/2-mile radius of the proposed project?

Yes X No _____

Explanation and Source:

There are 40 private residences within a ½ mile radius, most rely on private wells. No impact is anticipated since the lime will be complexed out in a few feet of groundwater.

6. Might the operation of the project result in any increased consumption of water? Yes _____ No X

Approximate consumption _____ gallons per day. Likely water source(s)_____

Explanation and Source:

Not applicable

7. Does the project involve any dredging? Yes _____ No X

If Yes, indicate:

Quantity of material to be dredged_____

Quality of material to be dredged_____

Proposed method of dredging_____

Proposed disposal sites_____

Proposed season of year for dredging_____

Explanation and Source:

None

G. Air Quality

1. Might the project affect the air quality in the project area or the immediately adjacent area?
   Yes _____ No X

   Describe type and source of any pollution emission from the project site._____

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any pollution emissions caused by the project, including construction dust? Yes _____ No X

   Explanation and Source:

3. Will access to the project area be primarily by automobile? Yes X No _____

   Describe any special provisions now planned for pedestrian access, carpooling, buses and other mass transit.

Since only miniscule changes in utilization will occur, present facilities are sufficient.

H. Noise

1. Might the project result in the generation of noise? Yes _____ No X

   Explanation and Source:
   (Include any source of noise during construction or operation, e.g., engine exhaust, pile driving, traffic.)

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any noise caused by the project? Yes _____ No X

   Explanation and Source:

I. Solid Waste

1. Might the project generate solid waste? Yes _____ No X

Explanation and Source:
(Estimate types and approximate amounts of waste materials generated, e.g., industrial, domestic, hospital, sewage sludge, construction debris from demolished structures.)

None

J. Aesthetics

1. Might the project cause a change in the visual character of the project area or its environs?
Yes X No _____

Explanation and Source:

After liming, the released nutrients may prompt an increase of the algal population, reducing transparency from 20 feet to 12 feet. (Federal Aid DJ Report F36R)

2. Are there any proposed structures which might be considered incompatible with existing adjacent structures in the vicinity in terms of size, physical proportion and scale, or significant differences in land use?
Yes _____ No X

Explanation and Source:

None

3. Might the project impair visual access to waterfront or other scenic areas? Yes _____ No X

Explanation and Source:

None

K. Wind and Shadow

1. Might the project cause wind and shadow impacts on adjacent properties? Yes _____ No X

Explanation and Source:

None

IV. CONSISTENCY WITH PRESENT PLANNING

A. Describe any known conflicts or inconsistencies with current federal, state and local land use, transportation, open space, recreation and environmental plans and policies. Consult with local or regional planning authorities where appropriate.

Since the Reagan Administration denies the impact of acid rain, this treatment conflicts with their view. Otherwise this action is entirely appropriate.

V. FINDINGS AND CERTIFICATION

A. The notice of intent to file this form has been/will be published in the following newspaper(s):

(Name) Cape Cod Times (Date) 3/15/84

_____ _____

_____ _____

B. This form has been circulated to all agencies and persons as required by Appendix B.

3/12/84 Joseph Bergin
Date — Signature of Responsible Officer or Project Proponent

Joseph D. Bergin
Name (print or type)

Address Div. of Fisheries & Wildlife
Field Headquarters, Westboro, MA 01581
Telephone Number (617) 366-4470

_____ _____
Date — Signature of person preparing ENF (if different from above)

_____
Name (print or type)

Address _____

_____

Telephone Number _____

Appendix B

Letter From Department of Environmental Quality Engineering
Relative to Wetlands Protection Act

ANTHONY D. CORTESE Sc. D
Commissioner

PAUL T. ANDERSON
Regional Environmental Engineer

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Quality Engineering
Southeast Region

Lakeville Hospital, Lakeville, Massachusetts 02346
947-1231, Ext. 680-684

January 30, 1984

Massachusetts Division of Fisheries
and Wildlife
Field Headquarters
Westboro, Massachusetts 01581

RE: TRURO--Wetlands - File No. SE 75-87

ATTENTION: Joseph D. Bergin

Gentlemen:

Following an in-depth review of the above-referenced file and in accordance with Massachusetts General Laws, Chapter 131, Section 40, the Department of Environmental Quality Engineering has approved the proposed project and has issued the enclosed Superseding Order of Conditions. The Department has determined that the proposed project is significant to the following interests of the Act: private water supply, groundwater supply, prevention of pollution and protection of fisheries.

The Department has determined that the proposed liming program is subject to the Massachusetts Wetlands Protection Act. It is the Department's opinion that the addition of agricultural limestone ($CaCO_3$) to highly acidic pond water, for the purpose of increasing its pH and reestablishing its natural buffering capacity, will not cause long-term detrimental impacts but will in fact protect the fisheries resource and enhance the natural ecology of the pond. Initially lime application may cause minor physical, chemical and biological changes in the pond but as the pH rises and stabilizes, the water quality will improve and the biological activity (flora and fauna) in the pond should increase. In addition, since the suggested pH range for drinking water is 6.5 - 8.5 p.p.m. it is highly unlikely that the use of lime to buffer ponds, in the quantities proposed, will cause unacceptable pH levels (high alkalinity) in drinking water supplies.

310 CMR 10.53(4) states that the issuing authority may approve a project that improves the natural capacity of a resource area(s) to protect the interests identified in the Act. The proposed liming program will not adversely alter the resource area and in the Department's opinion the natural pond habitat will be improved and the interests of the Act protected.

The Department recommends that a letter be drafted by the Division of Fisheries and Wildlife that explains your liming program (i.e. data that indicates the necessity for liming, application techniques utilized, expected impacts and benefits from liming a pond.) In future filings for pond liming, under Massachusetts General Laws, Chapter 131, Section 40, this letter could be submitted to the local Conservation Commissions along with the Notice of Intent. The results of any baseline studies, supported by the Division of Fisheries and Wildlife, which may be conducted on Cape ponds (such as anticipated for Great Pond and Ryders Pond in Truro) should also be made available to the local Conservation Commissions upon request.

In the opinion of the Department, the reasons given here are sufficient to justify this Superseding Order of Conditions. However, the Department reserves the right, should there be further proceedings in this case, to raise additional issues and present further evidence as may be appropriate.

Very truly yours,

For the Commissioner

Robert P. Fagan

Robert P. Fagan
Deputy Regional Environmental Engineer

F/EK/jt

cc: Conservation Commission

Appendix C

Correspondence from Department of Environmental Quality Engineering
Division of Water Pollution Control

ANTHONY D. CORTESE, Sc. D.
Commissioner

The Commonwealth of Massachusetts

Executive Office of Environmental Affairs
Department of Environmental Quality Engineering
Division of Water Pollution Control
One Winter Street, Boston 02108

October 15, 1984

Peter Oatis
Assistant Director of Fisheries
Massachusetts Division of Fisheries and Wildlife
Field Headquarters, Lyman School, Route 9
Westborough, MA 01581

Re: Liming of Lakes

Dear Mr. Oatis:

This letter is to support your Division's research on the liming of lakes in Massachusetts. Large portions of the Commonwealth are susceptible to acid waters due to both natural and man-made conditions. Lake liming may be a possible short-term solution to this problem.

In order to document the impacts of this procedure I favor the careful monitoring of lakes before, during and after liming. This data will provide the necessary information for future activities. When possible this Division will offer its technical support to your research. As you know my Technical Services Branch is already involved in a coordinated study with your office of Ryder and Great Ponds on Cape Cod. This type of study should further our understanding of the liming process.

Very truly yours,

Thomas C. McMahon

Thomas C. McMahon
Director

TCM/ac

Appendix D

COMMONWEALTH OF MASSACHUSETTS
Division of Fisheries and Wildlife

Departmental Memorandum

Date: September 17, 1984

To: Peter Oatis

From: Richard Keller

Subject: Effects of Liming 1/2 - 1.0 Ton Per Acre

December 15, 1982

1. pH increase by 1-2 pH units. Extreme: pH 4-7.
2. Total alkalinity: increase 2-3x, range 3-10 ppm. Extreme: 7x to 18.0 ppm.
3. Total hardness: no change to 2-3x increase, range 6-12 ppm. Extreme: 5x increase to 20.0 ppm.
4. Ca^{++}: 2-3x increase, range 2-3 ppm. Extreme: 5x increase to 5.0 ppm.
5. mg^{++}: no change to 1.5x increase, range 0.6-1.5 ppm. Extreme: 3x increase to 2.5 ppm.
6. Na^{++}: no change to 2x reduction. Extreme: 7x reduction.
7. Zn^{++}: Seventy-five percent reduction to undetectable amounts.
8. Mn^{++}: slight reduction to almost total reduction.
9. Co^{++}, Cr^{++}, Ny^{++}, Pb^{++}: trace to none before and after liming.
10. K^{+}: no change to 50 percent reduction.
11. $SO4^{=}$: no change to 3x reduction.
12. SC: normally 2x increase. Extreme: 5x increase, but short duration.
13. FE^{++}: no change to a slight reduction.
14. CL-: no change to 50% reduction.
15. Transparency: Variable: no change to 50% reduction. Improvement also noted.

16. D. O. A reduction in hypolimnion during summer and fall near bottom one year after liming. At 2-4 years after liming there is a possible severe hypolimnion reduction recovering after fifth year. Some ponds exhibited no significant change.

    Liming with $CaCO_3$ significant changes within 2 months - 6 months, maximum effects 2-4 years following liming. Ponds return to preliming acid conditions 6-10 years after liming.

Appendix E. pH and Total Alkalinity Readings of Great Pond, Truro

Date	pH	Total Alkalinity
2/ 6/71	5.6	--
3/10/71	5.1	--
2/22/72	5.6	--
3/ 2/73	5.4	--
3/19/73	5.5	--
2/26/74	6.0	--
1/22/75	6.3	--
2/19/75	6.5	--
3/ 8/75	6.7	--
2/20/76	4.9	--
3/ 2/76	6.9	--
3/ 7/77	6.5	--
2/28/78	6.5	--
2/ 7/79	6.0	--
3/ 5/79	6.6	--
3/12/79	6.4	--
3/12/80	6.7	--
3/ 6/81	5.7	1.35
3/12/81	6.2	2.8
3/15/82	5.6	1.35
3/25/82	6.2	2.8
2/15/83	5.5	0.8
3/25/83	5.5	0.6
4/12/83	5.2	0.4
4/22/83	5.5	0.85
5/ 3/83	5.6	0.7
2/23/84	5.25	0.65
3/20/84	5.42	0.60
4/17/84	5.65	0.10

Appendix F
Schedule for Study of Physical, Chemical and Biological Impacts
of Liming A Cape Cod Kettle Pond

Pretreatment	
Feb. 1984 - March 1985	Monthly Sampling Great and Ryder Ponds water chemistry zooplankton phytoplankton benthic invertebrates
May 1984	Fisheries survey Great and Ryder Ponds
August 1984	Fisheries survey Great and Ryder Ponds
Treatment	
March 1985	Apply lime by boat
Post Treatment	
Short-term April 1985 - March 1986	Monthly Sampling Great and Ryder Ponds water chemistry zooplankton phytoplankton benthic invertebrates
July 1985	Fisheries survey Great and Ryder Ponds
April 1985 - March 1986	Quarterly Reports
Long-term April 1986 - March 1988	Quarterly Sampling Great and Ryder Ponds water chemistry benthic invertebrates zooplankton phytoplankton
May 1986 & 1977	Fisheries survey Great and Ryder Ponds
August 1986 & 1987	Fisheries survey Great and Ryder Ponds
April 1986 - March 1988	Annual Reports
June 1988	Final Report

United States Department of the Interior

NATIONAL PARK SERVICE

CAPE COD NATIONAL SEASHORE
SOUTH WELLFLEET, MASSACHUSETTS 02663

IN REPLY REFER TO:

RECEIVED
APR 27 1984
OFFICE OF THE SECRETARY OF
ENVIRONMENTAL AFFAIRS

April 25, 1984

L7621

Mr. James S. Hoyte, Secretary
Executive Office of Environmental Affairs
20th Floor
100 Cambridge Street
Boston, MA 02202

Attention: MEPA Unit, EOEA No. 5148

Dear Mr. Hoyte:

We have reviewed the ENF for Liming of Acidified Waters; Statewide, and offer the following comments:

1. Documented and potential adverse ecological effects from liming are given only token reference. The "impact of acid rain" Statewide should be documented, especially given probable gross change in water chemistry and biology following proposed liming.

2. Comments related to specific ENF responses are:

I.	"increased loads of acidic precipitation" - No data is presented to show which ponds have been affected.
I.D.	Long-term impacts on Vegetation and Aesthetics are also appropriate considerations.
III.C.1.&2.	Response assumes that Massachusetts Natural Heritage Program knows where all rare species are. However, their inventory is almost certainly incomplete since most observations are fortuitous. All ponds to be limed should be surveyed for rare species.
III.F.5.	Could liming affect EPA/DEQE water quality standards other than pH?

Sincerely,

Herbert Olsen
Superintendent

cc: Environmental Compliance Division, NPS
North Atlantic Regional Office

Response to Comments on Environmental Notification Form

Department of the Interior (National Park Service)

1) Q. (Question) Doesn't liming produce adverse effects?

   A. (Answer) The adverse effects are noted in section IV of the Environmental Impact Report (E.I.R.).

2) Q. Please provide data showing increased loads of acid precipitation.

   A. The data base, noted in section III, of the E.I.R. identifies some acidified waters and estimates the total number statewide. On-going survey work will identify additional waters. Godfrey's preliminary A.R.M. report notes sulfate deposition in our state, 31-38 kg/ha, is well above the range at which damage may occur. Additionally, numerous reports of the Environmental Protection Act (E.P.A.), and National Academy of Science concerning the unnatural increases in acidic precipitation have been published during recent years.

3) Q. Long-term impact on vegetation and aesthetics?

   A. This area was scoped by Massachusetts Environmental Protection Act (M.E.P.A.) and is addressed in sections III and VI.

   Aesthetics are a very subjective area in which long-term impacts will not occur. The lime turns the bottom white, but is not apparent after approximately a three week period. Algal increases may occur during the two post liming growing seasons. Our studies of ponds on Cape Cod indicate transparency drops from an average of 18 feet (perhaps an unnatural transparency due to acidification) to 12 feet for a year or two then returns to preliming levels. This is still considered remarkably clear water to the general public and therefore aesthetically pleasant.

4) Q. Will all ponds to be limed be checked by Natural Heritage?

   A. The Natural Heritage staff will screen and inspect all candidate waters prior to liming as mentioned in section VI.

United States Department of the Interior
NATIONAL PARK SERVICE
CAPE COD NATIONAL SEASHORE
SOUTH WELLFLEET, MASSACHUSETTS 02663

IN REPLY REFER TO:

RECEIVED
APR 27 1984
OFFICE OF THE SECRETARY OF
ENVIRONMENTAL AFFAIRS

April 25, 1984

L7621

Mr. James S. Hoyte, Secretary
Executive Office of Environmental Affairs
20th Floor
100 Cambridge Street
Boston, MA 02202

Attention: MEPA Unit, EOEA No. 5147

Dear Mr. Hoyte:

We have reviewed the ENF for Liming Acidified Waters; Great Pond, Truro, and offer the following comments:

1. Documented and potential adverse ecological effects for liming are given only token reference. The "impact of acid rain" at Great Pond and elsewhere should be documented, especially given probable gross change in water chemistry and biology following proposed liming.

2. Comments related to specific ENF responses are:

I.C. "to offset impact of acid rain" - No data is presented to show that Great Pond has been affected (also II.F.2.).

I.D. Long-term impacts on Vegetation, Water Pollution and Aesthetics (see III.J.) are also appropriate considerations.

III.A. "20 years of experience" - data is necessary to substantiate statement.

III.C.1. Adverse impacts and expected severity needs elaboration. Liming is intended to preserve the trout stocking program not existing fish and wildlife resources.

2. Effects on vegetation and other resources should receive elaboration and be site specific.

3. Wetlands will be altered with changes in water chemistry.

5. Although shoreline is stable, it is geologically sensitive and subject to potential impact.

III.D.1. Complete analysis of "lime" is necessary to evaluate potential impact.

III.F.2. Lime is a substance out of place in Cape Cod ponds; it could function as a pollutant, dependent on actual composition of material used and ecological effects on acidic kettle ponds.

5. Explain, with references, how lime is "complexed out" in groundwater.

IV.A. "entirely appropriate" is too strong a statement without exhaustive discussion of the justification of need based on Great Pond water chemistry and potential and documented impacts.

This section should be expanded to include all the controversies associated with liming - changing the water chemistry and its effects on aquatic plants and animals.

- Artificially maintaining environments to perpetuate non-native species of fish for recreational purposes is inconsistent with National Park Service policy. Inasmuch as the underwater land and biology may be adversely affected through the addition of lime to this water, National Park Service policy may be applicable.

Sincerely,

Herbert Olsen

Herbert Olsen
Superintendent

cc: Environmental Compliance Division, NPS
North Atlantic Regional Office

Department of the Interior (B) National Park Service

1) Q. Please document the impact of acid rain at Great Pond and elsewhere.

A. The intent of liming acidifying waters is to prevent the adverse impacts from occurring. Spring pH's recorded over recent years demonstrate the increasing acid concentration of Great Ponds waters subsequent to the last lime application conducted in 1973 (Appendix E).

2. Q. Elaborate on twenty years of experience.

A. See Introduction and Section I and Appendix (D).

3) Q. Isn't liming intended only to enhance trout stocking?

A. No, liming is intended to preserve the diversity and integrity of existing aquatic habitats.

4) Q. Please elaborate on the effects of liming upon vegetation and other aquatic resources at Great Pond.

A. Presently the Division of Fisheries and Wildlife, Division of Water Pollution Control and Massachusetts Audubon Society are intensively studying the effects of liming upon chemistry, plankton, benthic organisms, vegetation and fish at Great Pond. These studies will document before and after effects of liming at Great Pond in detail.

5) Q. Will liming significantly alter wetlands?

A. No. Our present liming operations do not cause significant alterations in pH, as stated previously they are intended to preserve existing aquatic habitats from significant alteration due to chronic and unchecked acidification.

6) Q. Will liming upset geological integrity of the shoreline?

A. No, there is no evidence based upon our experience or discovered in our literature review to suggest liming may disrupt the geological integrity of the shoreline.

7) Q. Do you intend to analyze limestone before application?

A. Yes, see Section VI.

8) Q. Will lime function as a pollutant in Cape Cod ponds?

A. No, see Appendix 3.

9) Q. How is lime "complexed out" on groundwater?

A. The basic reactions noted in the Environmental Notification Form (E.N.F.) involves the following reactions:

$CaCO_3 + H^+ \rightarrow Ca^2 + HCO_3^-$ #1

$Ca^{2+} + 2\ HCO_3^- \rightarrow CaCO_3\downarrow + H_2O + CO_2$ #2

$HCO_3^- + H^+ \rightarrow H_2CO_3$ #3

$H_2CO_3 \rightarrow H_2O + CO_2$ #4

then this material from #2 reacts with soil colloidal matter, identified here as Micelle, one of a number of clay particle types:

$Ca\ \boxed{\text{Micelle}} + 2\ H_2CO_3 \rightarrow \underset{H}{H}\ \boxed{\text{Micelle}} + Ca(HCO_3)_2$ #5

as another example

$\underset{H}{H}\ \boxed{\text{Micelle}} + CaCO_3 \rightarrow Ca\ \boxed{\text{Micelle}} + H_2O + CO_2$ #6

$\underset{H}{H}\ \boxed{\text{Micelle}} + Ca(OH)_2 \rightarrow Ca\ \boxed{\text{Micelle}} + 2H_2O$ #7

$\underset{H}{H}\ \boxed{\text{Micelle}} + Ca(HCO_3)_2 \rightarrow Ca\ \boxed{\text{Micelle}} + 2H_2O + 2CO_2\uparrow$ #8

$\underbrace{2KALSi_3O_8}_{\text{microline feldspar}} + H_2CO_3 + H_2O \rightarrow H_4AL_2Si_2O_9 + K_2CO_3 + 4SiO_2$ #9

The first four reactions are from:

Fraser, J. E. and D. Britt. 1980. Liming of Acidified Waters: A review of Methods and Effects on Aquatic Ecosystems, General Research Corp., McLean, Virg., 189 pp.

The second set are from:

Buckman, H. O. and Brady, N. C. 1968. The Nature and Properties of Soils. MacMillan Co., New York. 567 pp.

10) Q. Does liming conflict with National Park Service policy?

A. No. Although National Park Service policy may not support liming, the operating policy is overruled by the Seashore's enabling legislation.

According to PL 87-126, 75 Stat. 284 the Superintendent "may develop for appropriate public uses such portions of the Seashore as he deems especially adaptable for camping, swimming, boating, sailing, hunting, fishing..." With this in mind, the lake has been reclaimed and limed to provide recreational fishing.

CONSERVATION
EDUCATION
RESEARCH

MASSACHUSETTS AUDUBON SOCIETY
LINCOLN, MASSACHUSETTS 01773 • TEL. 617-259-9500

RECEIVED
MAY 7 1984
OFFICE OF THE SECRETARY OF
ENVIRONMENTAL AFFAIRS

Secretary Jamie Hoyte
Executive Office of Environmental Affairs
Attn: MEPA Unit; Attn: David Shepardson
20th Floor
100 Cambridge Street
Boston, Massachusetts 02202

4 May 1984

Dear Secretary Hoyte,

We are participating with the Division of Fisheries and Wildlife on the experimental study of impacts of liming at Great Pond, Truro. Our participation arose from a perceived need for information about the impacts of the ongoing and proposed use of chemical bases to neutralize waters on Cape Cod for the maintenance of recreational fisheries and other values. We support the concept of a Generic Environmental Impact Report and urge that the following points be taken into consideration in preparing the E.I.R.

1. Criteria: The Division's criteria for choosing suitable sites for lime application rely solely on physical and chemical factors influencing effectiveness (depth, sediment type, metals, flushing rate, and so on). Two other criteria should be considered: vulnerability to damage from acid rain; and active decision to maintain an unnatural community.

Vulnerability to or damage from acid rain.

The Division's justification for liming is that it will "offset the impact of acid rain" and "prevent the deterioration of communities from the real threat of increased environmental acidification". The E.I.R. should present evidence that specific water bodies proposed for liming are indeed either impacted by acid rain or threatened by acidification.

Alkalinity and pH data alone are insufficient evidence of vulnerability to damage from acid deposition, particularly for kettle ponds, whcih are fed by groundwater rather than surface drainage and which are naturally poorly buffered and somewhat acidic. It is necessary to show either that acid deposition has been influencing water chemistry and the aquatic biota or that rates of acid inputs into the ponds via soils, groundwater systems, and direct precipitation are such that chemical changes can be predicted, based on known models of the acidification process.

Data indicating that impacts have been occurring could include historical records of pH, alkalinity, and major ions, which should be compared with current values to demonstrate trends of decreased pH and bicarbonate alkalinity and increased sulfate. Current data with good quality control, such as the data

from the statewide Acid Rain Monitoring Project (A.R.M.), if they indicate that non-marine sulfate levels are significantly higher than predicted for clearwater lakes of the type proposed for liming, could also serve as evidence of impacts of acid deposition on water chemistry.

Such evidence should be available before a water body is judged suitable for liming.

Management Choices.

Historically in Massachusetts, liming has been used to improve suitability of waters for production of trout and other game fish. In some cases, this has resulted in establishment of artificial communities in habitats that would not naturally support them. While not all ponds proposed as candidates for liming support artificially maintained communities, it should be recognized that chemical changes caused by liming may lead to changes in the natural community that is present.

Most waters suitable for liming are naturally low in calcium. Calcium has a greater influence on the distributions of many types of aquatic organisms than does pH. The possibility that increases in calcium resulting from lime application may lead to losses of phytoplankton, zooplankton, macroinvertebrates, and aquatic plants typical of poorly buffered, calcium-deficient waters, should be considered.

In such cases, it should be recognized that liming is a management decision to maintain an unnatural biological community.

2. Nature of chemical bases used and application techniques employed.

The effects and effectiveness of liming vary considerably with the chemical base used for the neutralization. Calcium oxide (CaO) is extremely caustic, highly soluble, and of short-lived effectiveness; calcium hydroxide ($Ca(OH)_2$) is less caustic but also highly soluble and of short-lived effectiveness; calcium carbonate ($CaCO_3$) is least caustic, less soluble, but with longer-lasting effects on pH and alkalinity.

The E.N.F. summarizing the Great Pond liming proposal states that the agricultural lime supplied by Conkline lime of Rhode Island consists primarily of CaO. Most researchers in the field recommend that agricultural limestone, $CaCO_3$, be used for liming in preference to CaO and $Ca(OH)_2$, since the former results in a far less rapid change in pH and in fewer toxic side effects, as well as maintaining effectiveness over a longer period of time. Differences in impacts resulting from use of different liming products should be considered in the E.I.R., and the chemistry of the bases used by the Division should be clearly and carefully identified. Calcium carbonate should be the chemical of choice for liming in the Commonwealth.

3. Impacts.

Impacts of liming to prevent deterioration in waters that have been judged critical in terms of potential for acidification will be different from impacts of liming in waters that have already been negatively impacted by acid rain.

Ideally, separate Generic Environmental Impact Reports might be prepared for these two categories of liming projects. In a single G.E.I.R., the impacts on acidified waters should be discussed separately from those on waters being limed for maintenance purposes.

The possibility of designing a research program to evaluate impacts of liming on acidified kettle ponds, in addition to the ongoing study of maintenance liming at Great Pond, should be considered.

Sincerely,

Elizabeth A Colburn

Elizabeth A. Colburn
Staff Aquatic Ecologist
Environmental Science Department

Massachusetts Audubon Society

1) Q. The Division should consider vulnerability to damage from acid rain as a criteria for liming consideration.

A. Section VI identifies that this is a consideration given to pond liming candidates. Only ponds classified as acidified or critical will be considered for liming.

2) Q. There should be an active decision to maintain unnatural communities.

A. If this statement means we should consider rare or unique species or habitats prior to lime application the issue is covered in Section VI, otherwise the term "unnatural community" needs a better definition.

3) Q. Calcium carbonate should be the chemical of choice for lake liming in the Commonwealth.

A. The Division of Fisheries and Wildlife intends to continue using only calcium carbonate (ground agricultural limestone) until such time as a more environmentally sound and cost effective agent is documented.

Nashua River Watershed Association

184 Main Street, Fitchburg, Massachusetts 01420 Telephone 342-3506

April 19, 1984

RECEIVED

APR 23 1984

OFFICE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS

David Shepardson, MEPA Unit
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

RE: Statewide Liming, File No. 5148

Dear Mr. Shepardson:

The Nashua River Watershed Association would like to comment on the ENF for the above-referenced project, the proposal of the Division of Fisheries and Wildlife (MDFW) to lime acidified water bodies.

It is obvious that this project will require the preparation of an EIR (10.32 (5)(2)). The project's intent is certainly meritorious, but there appear to be data gaps concerning details of project implementation, as well as "side effects" upon biota. We feel that the scoping document should include, among others, the following concerns:

- A distinction must be made between preserving water bodies and restoring those which have already undergone acidification and lost most "normal" biota. Although the ENF notes that the program would "preserve and protect" threatened resources, other information, e.g., item F(5), states that "this project will raise the pH." There certainly is harm to most species from low pH, however, there can also be impacts as the pH is raised. For example, aluminum may be (chemically) more toxic at about 5.2 than at a lower pH, and may become physically damaging to gills at 6.0. Other toxic metals may be re-dissolved from bottom sediments and elsewhere. Restoration of higher pH will have to address such phenomena. Alternatively, MDFW should describe how susceptible water bodies will be identified and avoided.

- For the last two seasons, near-100% mortality has occured among recently - stocked fish in certain Quabbin Reservoir tributaries. While precise causes aren't now known, one suggestion is that more acid streams meeting less acid lake water create an as yet unidentified stress. How will the natural tendancy of many fish species to move to this more acid "death zone" be addressed?

- The process of choosing water bodies for treatment should be explained and supported. Will factors include public access; watershed/water column metals, flushing rate, stratification, geographic area, public opinion, bottom type, etc.?

- The decision process for involving DEQE's wetlands division should be explained.

Thank you for the opportunity to comment on this project. We look forward to discussing the liming program further with MEPA and MDFW.

Very truly yours,

Ralph W. Perkins
Water Resources Director

RWP:sc

cc: J. Bergin

Nashua River Watershed Association

484 Main Street, Fitchburg, Massachusetts 01420 Telephone 342-3506

May 4th, 1984

RECEIVED

MAY 7 1984

OFFICE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS

Dear Dave:

As you requested, here are some further comments on the MDFW's liming proposal (No. 5148). I hope that you receive them in time for them to be useful - hence, my hurried hand writing.

Wednesday's meeting was very informative in terms of filling in some of the "gaps" in the ENF, to give a better picture of the overall project.

We still have a little concern over the so-called "death zone". The quick responses of fish species to, e.g., thermal or light gradients are well known. Can such responses to pH or metals gradients at stream mouths be counted upon to occur? Fish kills have apparently resulted, for example, at Quabbin Reservoir stream mouths in 1983. Perhaps through altering dosages, selecting the most appropriate time of year, adding chemicals with the lime to complex metal ions, or other means, liming could be carried

out more or less as proposed

Is bioaccumulation an issue here? Either negated through remobilization of metals & dilution, or positively via its reduction as a result of lining? Would even low-level bioaccumulation be magnified to harmful levels in fish-eating species?

We feel that such topics should be addressed in the EIR. Hopefully, literature citations or presently available data could be presented without diverting project resources excessively.

Sincerely,

Ralph L. Parkins

Water Resources Director

Nashua River Watershed

1) Q. Will there be liming associated fish mortalities due to the effect of metal precipitation?

   A. No. It is highly unlikely that this will occur because we will be considering the dissolved metal content prior to limestone application, see Section VI.

2) Q. Will bioaccumulation of toxic metals be exacerbated by limestone application?

   A. No. This should not be a problem at waters that are treated prior to long-term acidification.

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Management

00 Cambridge Street
Boston
Massachusetts
2202

Office of
Planning &
Development

MEMORANDUM

TO: Samuel Mygatt, Director, MEPA Unit

FROM: Katharine M. Preston, Scenic Rivers Program Coordinator

SUBJ: EOEA #5148 Liming of Acidified waters

DATE: April 30, 1984

Since it is likely that rivers already designated or proposed for designation are to be affected by the Division's liming, we would like to be notified of the geographical locations well in advance. The generic EIR should review closely all studies that have been done on this process. Although it may appear to be a method of returning an aquatic system to a more buffered state the rapid change itself may cause havoc on the system.

KMP:phb

Scenic Rivers

1) Q. Please notify the Scenic Rivers Program Coordinator of all waters that are to be limed.

   A. The Division of Fisheries and Wildlife will concur with the above request.

COASTAL ZONE MANAGEMENT

The Commonwealth of Massachusetts

Executive Office of Environmental Affairs

100 Cambridge Street

Boston, Massachusetts 02202

RECEIVED

MAY 8 1984

OFFICE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS

MEMORANDUM

TO: Sam Mygatt, MEPA Unit

FROM: Richard F. Delaney, Director, CZM

DATE: May 7, 1984

SUBJECT: Liming of Great Ponds EOEA File # 5147, 5148, 5149 and 5150

The Massachusetts Coastal Zone Management (MCZM) Office has reviewed the above referenced ENF's and offers the following comments:

1. That individual EIR's be waived for ponds which meet the criteria of the "liming decision pathway" as presented by Mr. Peter Otis at the MEPA Scoping Session on May 2, 1984. If liming is to be done on any ponds wich do not meet the above criteria, an individual EIR should be done.

2. That a generic EIR should be done for the statewide project, EOEA file #5148. The EIR should include: a listing of all the ponds that are to be considered, a description of their present status with regard to vulnerability to acid rain, an indication as to whether or not they meet the criteria for liming, the possibilities of other mitigating solutions, and a statement of their expected future status if no action is taken.

CAPE COD PLANNING AND ECONOMIC DEVELOPMENT COMMISSION
1ST DISTRICT COURT HOUSE, BARNSTABLE, MASSACHUSETTS 02630
TELEPHONE: 617-362-2511

RECEIVED
APR 19 1984
OFFICE OF THE SECRETARY OF
ENVIRONMENTAL AFFAIRS

April 11, 1984

Mr. Dave Shephardson
MEPA Unit
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, MA. 02108

Re: EOEA #5147 - Liming of Great Pond in Truro
EOEA #5148 - Liming of acidified ponds statewide
EOEA #5149 - Liming of Baker Pond in Orleans
EOEA #5150 - Liming of Schoolhouse Pond in Chatham

Dear Mr. Shepardson:

Cape Cod Planning and Economic Development Commission (CCPEDC) staff have reviewed the Division of Fisheries and Wildlife proposals for liming Baker Pond (Orleans), Schoolhouse Pond (Chatham), Great Pond, (Truro), and the liming of acidified ponds statewide.

If a statewide liming program is developed, chemical and biological parameters of aquatic communities should be closely monitored before, during and after treatment. A testing program consistent with Division of Water Pollution Control's Lake Restoration Program should be developed which includes chemical parameters, namely anions, cations and metals and biological components of the ecosystem such as macrophytes, fish populations, phytoplankton and zooplankton. Conducting such analyses is important to ensure that liming has no significant adverse impact on the aquatic environment.

An Environmental Impact Report (EIR) should be compiled for several ponds representative of those in various regions of the state. The purpose of an EIR would be to develop comprehensive data on the effects of liming.

Thank you for your consideration of these comments.

Very truly yours,

Robert E. Robes
Executive Director
RER:bc

Cape Cod Planning and Economic Development Commission

1) Q. Chemical and biological parameters of aquatic communities should be closely monitored before, during and after treatment.

A. In view of the abundant studies addressing this issue throughout North America and Scandanavia we do not believe it would be cost effective to study in great detail the biological, chemical and physical changes occurring at all limed waters. We are currently pursuing and will continue to pursue detailed evaluations of commercial effects at selected lakes and streams which represent existing and significantly different aquatic habitats.

NMAC

NORTHERN MIDDLESEX AREA COMMISSION

144 Merrimack St. Lowell, Mass. 01852, (617)454-3021, Joseph P. Hannon, Director

07

REQUEST FOR REVIEW COMMENTS 3/14/84

TO: BILLERICA, CHELMSFORD, DRACUT, DUNSTABLE, LOWELL, PEPPERELL, TEWKSBURY, TYNGSBOROUGH, WESTFORD: Board of Selectmen, City Manager, Planning Board, Conservation Commission, Board of Health, Town Administrator, Executive Secretaries, NMAC Commissioners

The Northern Middlesex Area Commission, pursuant to M.G.L. Ch.30 S.62 has received an Environmental Notification Form (ENF) concerning the following project: Liming of Acidified Waters (Statewide)

Your opinions and comments pertaining to the extent and significance of possible ENVIRONMENTAL impacts which are directly attributable to this project are most welcome. If you wish to comment, please do so below. For more information, please contact the Commission staff.

COMMENTS DUE: April 13, 1984

EOEA/NMAC REVIEW NUMBER: ENF #224

APPLICANT: Massachusetts Division of Fisheries and Wildlife (Field Headquarters)

EIR REQUIRED: (yes/no)

RECEIVED

APR 12 1984

N.M.A.C.

COMMENTS:

[ ] No significant environmental concerns
[X] Need more information about the following environmental aspects in order to comment. (Please explain below)
[X] Significant environmental concerns. (Please explain below)

Please see attached.

(Attach additional sheets if necessary)
(nmcb nav y)

Signature Michele Sterling Title/Department (Pepperell) Hazardous Waste Coord. Date 4/10/84

The purpose of an ENF is to present information relative to the proposed project which, along with comments received from officials, agencies, and citizens is used by the Secretary of Environmental Affairs to make a determination regarding the significance of any potential environmental impacts concerning the project. The Massachusetts Environmental Policy Act (MEPA) requires the Secretary to solicit local and regional comments prior to issuing a decision as to what measures, if any, are appropriate in order to mitigate damage to the environment. The Secretary may, for example, require the preparation of an Environmental Impact Report and may tailor the scope of such a document to specifically address certain identified concerns. Some projects automatically require the preparation of an EIR and if you wish to comment on specific items that you feel should be included within the scope of an EIR or be informed of the time and place of the scoping session please indicate on this form.

COMMENTS ON PROPOSED LIMING PROJECT SUBMITTED BY MASS. FISH & WILDLIFE
BY MICHELE G. STIRLING, B.S. MARINE BIOLOGY
M.S. ZOOLOGY
HAZARDOUS WASTE COORDINATOR-PEPPERELL

Neutralization of Massachusetts waters, through the addition of agricultural lime (Calcium hydroxide), is, at best, a "bandaid" solution to the major environmental problem of acid rain. Although it is a short-term remedy, liming may be the only defense we have until sulfur and nitrogen oxides, produced as a result of the burning of fossil fuels, are reduced on the industrial level.

Acidic waters are characterized by an increase in transperency, low phosphorous concentrations and elevated levels of metal cations such as Al, Mn, Zn, Cd and Pb. There is also a reduction in the number of species at all trophic (ie. feeding) levels, which may be induced by direct toxicity of the water, decreased leaching of phosphorus from the drainage area, competition for available phosphorus or changes in predator/prey relationships (Eriksson, et al, 1983). "Sensitive ecosystems", which are susceptible to acidification are, generally, headwater streams and lakes located in areas where soils are sandy, thin and predominantly composed of silicate materials (Schafran, 1983).

Although liming has its merits and probably should be applied to certain lakes (such as those containing unique or endangered species which are extremely susceptible to acidification) without undue delay, it should be noted that it is not feasible, scientifically sound or economically justifiable to lime all acid-sensitive and aquatic ecosystems within a region. For these reasons, careful consideration should be given to several criteria before neutralization targets are chosen. The criteria should include physical, biological, sociological and chemical factors (Anon, 1982).

I, personally, have found Mass. Fish and Wildlife to be lacking in such data, having talked to one of their spokesmen over the telephone. To date, they have little or no data concerning: water chemistries, pre or post-acidic phytoplankton or zooplankton population studies, benthic studies concerning substrate types or benthic organisms such as crayfish, insect larvae, molluscs, etc. They have no data on algae or macrophytes (aquatic vegetation, such as Sphagnum moss, Phragmites, Equisetum).

Mass. Fish & Wildlife does have "some" pH and temperature profiles, "some" fish growth data, some stomach-content data, but it appears that they are basing their proposal primarily on speculation.

Their main criteria for liming is a loss of buffering capacity (2ppm) and whether the lake has a muddy substrate(eutrophic lakes with mud bottoms are difficult to lime as the neutralizing agent disappears into the substrate), or if it is a bog.

If the above data (physical, biological, etc.) is not available, there is no way to predict what effects the proposed liming will have on the aquatic communities. One must also keep in mind that some Mass. waters are naturally acidic (kettle ponds and bogs of Cape Cod) and/or low in productivity and that liming would be deleterious to biota occupying those habitats. Another thing to remember is that lakes, ponds and streams will eventually return the acidic state, based on their flush rates. Once begun, neutralization projects must be monitered and maintained. Fish mortality, due to metal toxicity comes into play here, as well as maintenance of pH at desirable levels. Trace metals (eg. aluminum, zinc, lead, cadmium) present in the water column of an acidic lake will be deposited to sediments upon liming. If a lake is allowed to reacidify, these metals will readily be reintroduced to the lake water column (Schafran, 1983).

The effects of adding alkaline material to mitigate the ecological effects of acid rain are controversial and contradictory - probably because ponds and lakes vary with regard to natural acidity, dissolved metals, acid runoff, geological profiles and turnover rates, etc. Some of these controversies are detailed in the 1982 Electric Power Research Institute Feasibility Report(Fraser,et al,1982).

It has been documented that the first spring thaw is several times more acidic than snow, as a whole, and that this so-called chemical acid surge effects lakes in which turnover time of water is long. (It may be noted here that Mass. Fish & Wildlife plans to lime lakes with turnover rates-of 1 year). Incoming thaw-water is highly acidic and contains high concentrations of metals. The thaw-water collects under the ice along the shores, getting into the most important reproductive areas of lakes. The effects are often devastating and can occur even after the lakes are limed (Swedish Ministry of Agriculture, 1982). According to the Ministry, the only right way to counteract acidity is to lime incoming waters, but it is too expensive to do this. They also suggest that water management exacerbates the acid rain problem in acid-sensitive waters by collecting highly acidified melt-water and draining off water of higher pH too early in the year. The Ministry maintains that "reversed management would give considerable gains in water husbandry, but since it runs counter to hydroelectric interests" it would prove to be quite costly.

Choosing which lakes to lime is a difficult task, which may be guided by the following criteria:

1. lakes having a pH of less than 5.5 during the summer, at the surface (Pfeiffer, 1983.).
2. ponds having less than 100 acres
3. the flushing rate must be relatively long. If the lake has a long turnover time, application may be effective 10-15 years, but short turnover time can lead to overdoses of lime and short-lived effects (Bengtsson, et al , 1980.).
4. lakes where serious decline in sport fishery is apparent and where preservation and maintenance of unique fish is important.
5. lakes where maintenance of threatened or endangered species requires liming
6. lakes having little or no buffering capacity
7. lakes without high concentrations of iron, since iron humates are precipitated onto lime while it is still undissolved, preventing further dissolution
8. lakes not fed by acidic groundwater, melt-water or acidic soils.

Rodhe (1981) has suggested culturing acid-tolerant species and development of new biological communities with which to restock acidified waters, as an alternative remedy until emissions stop and acidification is halted. This is an area which needs more research but I question whether his method could keep up with rapid industrial emissions.

Review of Swedish and Norwegian liming studies may be beneficial, as they point out the pros and cons of adding neutralizers. The situation in North America may be even more complex, however, because North American lakes generally contain more species of fish than Scandinavian lakes do. Therefore, the potential for disruption in the aquatic food chain is greater. It could happen that fish populations would survive in treated lakes, but the normal distribution of species might be altered. For example, inputs of iron might disrupt life cycles of some species more than others, changing the ecological balance among species (U.S. - Canada Memo, 1983).

There are conflicting reports as to the effects of lime on phytoplankton populations, but it is well documented that acid-tolerant species will be replaced by less acid-tolerant species after liming(EPRI, 1982). Neutralization of acid lakes near Sudbury, Ontario caused aerobic heterotrophic bacteria to increase by several orders of magnitude and this may not always be beneficial (EPRI, 1982). These bacteria may cause fin rot in some species of fish.

Zooplankton appear to be relatively slow in recovering after the addition of a neutralizer, taking several years to regain their pre-neutral biomass. Again, less acid-tolerant species replace acid-tolerant ones (EPRI, 1982). Some bentnic macro-invertebrates (Chironomids) were totally eradicated in acid lakes were introduced, generally successfully, to several limed lakes in Sweden.

SOURCES

Anon. 1982. Study liming acidified surface waters. Lake Line 2(2): 5,15.

Bengtsson, Bo, William Dickson, and Per Nyberg. 1980. Liming acid lakes in Sweden. Ambio 9: 34-36.

Eriksson, Fritz, Einar Hornstrom, Per Mossberg and Per Nyberg. 1983. Ecological effects of lime treatment of acidified lakes and rivers in Sweden. Hydrobiologia 101: 145-164.

Fraser, J., D. Hinkley, R. Burt, and R.R. Severn.1982. Feasibility Study to utilize lining as a technique to mitigate surface water acidification. Electric Power Research Institute, EPRI EA-2362, Interim Report. 116 pp.

Pfeiffer, Martin, H. 1983. DEC's lake neutralization program for acidified Adirondack waters. Adirondac Sept. 1983: 19-21.

Rodhe, Wilhelm. 1981. Reviving acidified lakes. Ambio 10: 195-6.

Schafran, Gary C. 1983. Neutralization of acidic waters by base addition. Adirondac October/November 1983: 16-18.

Swedish Ministry of Agriculture, Environment '82 Committee. 1982. Acidification Today and Tomorrow. pp.118-32; 194-206.

U.S. - Canada Memorandum of Intent on Transboundary Air Pollution. Jan., 1983. Final Report, Work Group I, Impact assessment. Section 9. Liming.

Northern Middlesex Area Commission

Ms. Michele G. Stirling, Hazardous Waste Coordinator of Pepperell, raised a number of points of concern regarding the criteria for selection of waters to be limed.

We believe that adequate responses to the comments can be found in Section VI.

NMAC NORTHERN MIDDLESEX AREA COMMISSION
144 Merrimack St. Lowell, Mass. 01852, (617) 454-8021, Joseph P. Hannon, Director

MAR 16 1984

REQUEST FOR REVIEW COMMENTS 3/14/84

TO: BILLERICA, CHELMSFORD, DRACUT, DUNSTABLE, LOWELL, PEPPERELL, TEWKSBURY, TYNGSBOROUGH, WESTFORD: Board of Selectmen, City Manager, Planning Board, Conservation Commission, Board of Health, Town Administrator, Executive Secretaries, NMAC Commissioners

The Northern Middlesex Area Commission, pursuant to M.G.L. Ch.30 S.62 has received an Environmental Notification Form (ENF) concerning the following project: Liming of Acidified Waters (Statewide)

Your opinions and comments pertaining to the extent and significance of possible ENVIRONMENTAL impacts which are directly attributable to this project are most welcome. If you wish to comment, please do so below. For more information, please contact the Commission staff.

COMMENTS DUE: April 13, 1984

EOEA/NMAC REVIEW NUMBER: ENF #224

APPLICANT: Massachusetts Division of Fisheries and Wildl (Field Headquarters)

EIR REQUIRED: (yes/no)

RECEIVED
MAR 28 1984
N.M.A.C.

COMMENTS:

[ ] No significant environmental concerns
[X] Need more information about the following environmental aspects in order to comment. (Please explain below)
[ ] Significant environmental concerns. (Please explain below)

Will this involve Forge Pond?
A diagnostic study is planned for this year

(Attach additional sheets if necessary)
(nmcb nav y)

Signature Charles Mengi Title/Department Westford Board of Health Date 3/24/84

The purpose of an ENF is to present information relative to the proposed project which, along with comments received from officials, agencies, and citizens is used by the Secretary of Environmental Affairs to make a determination regarding the significance of any potential environmental impacts concerning the project. The Massachusetts Environmental Policy Act (MEPA) requires the Secretary to solicit local and regional comments prior to issuing a decision as to what measures, if any, are appropriate in order to mitigate damage to the environment. The Secretary may, for example, require the preparation of an Environmental Impact Report and may tailor the scope of such a document to specifically address certain identified concerns. Some projects automatically require the preparation of an EIR and if you wish to comment on specific items that you feel should be included within the scope of an EIR or be informed of the time and place of the scoping scession please indicate on this form.

The following list of officials had no significant environmental concerns with liming:

Billerica representative to N.M.A.C.

Chelmsford Conservation Commission

Chelmsford Executive Secretary

Chelmsford representative to N.M.A.C.

Dracut Board of Health

Dracut Executive Secretary

Lowell representative to N.M.A.C.

Pepperel Board of Selectmen

Pepperel Executive Secretary

Tewksbury Conservation Commission

Tewksbury Board of Health

Tyngsboro Planning Board

Tyngsboro representative to N.M.A.C.

Westford Executive Secretary

Westford representative to N.M.A.C.

THE MARTHA'S VINEYARD COMMISSION

BOX 1447
OAK BLUFFS
MASSACHUSETTS
02557
617-693-3453

May 2, 1984

RECEIVED
MAY 3 1984
OFFICE OF THE SECRETARY OF
ENVIRONMENTAL AFFAIRS

Secretary
Executive Office of
Environmental Affairs
100 Cambridge Street
Boston, MA 02202

Attention: MEPA Unit
David Shepardson

Dear Mr. Shepardson:

Enclosed are my comments in regard to the Liming of Acidified Waters Project - Statewide, EOEA #5148.

1. Most probably the proper way to evaluate this liming program is by means of a Generic Environmental Impact Report.

2. A specific monitoring program should be used to evaluate the impacts of the liming procedure and feasibility of future liming for ponds in the Statewide program.

3. A chemical analysis of lime should be conducted and or evaluated before it is placed in each individual pond.

4. The Massachusetts Natural Heritage Program should be consulted prior to liming each individual project.

5. The Wetlands Division of DEQE should be consulted prior to liming each individual pond whenever a wetlands impact appears possible. (I am assuming this would become obvious through contacts with Local Conservation Commissions.)

If I can be of any further assistance, please let me know.

Sincerely

Carol Borer
Planner

CB/phd

SRPEDD
SOUTHEASTERN REGIONAL PLANNING AND ECONOMIC DEVELOPMENT DISTRICT
25 BARNUM STREET, TAUNTON, MASSACHUSETTS 02780 TEL. (617) 824-1367

April 30, 1984

RECEIVED
MAY 3 1984
OFFICE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS

James Hoyte, Secretary
Executive Office of
Environmental Affairs
100 Cambridge Street
Boston, MA 02202

ATTN: MEPA Unit

REF: EOEA #5148/Statewide
Liming of Acidified Waters

Dear Secretary Hoyte:

We have received the above referenced Environmental Notification Form for review and comment under the provisions of the Mass. Environmental Protection Act.

As the regional planning agency, the Southeastern Regional Planning and Economic Development District would like to be notified of any proposed activities in the district.

If you have any questions, please contact me or Steven Reckhow, Principal Environmental Planner/Engineer.

Sincerely,

Stephen S. Smith
Executive Director

SCS:MSS:spg

cc: Mass. Division of Fisheries and Wildlife

SRPEDD is an autonomous regional planning and economic development agency. Established by state law, SRPEDD is governed by a Commission comprised of representatives from member communities: Acushnet, Attleboro, Berkley, Carver, Dartmouth, Dighton, Easton, Fall River, Freetown, Lakeville, Mansfield, Marion, Mattapoisett, Middleborough, New Bedford, North Attleborough, Norton, Plainville, Raynham, Rehoboth, Rochester, Seekonk, Somerset, Swansea, Taunton, Wareham, Westport